# SCIENTIFIC AMERICAN SUPPLEMENT. No. 1390

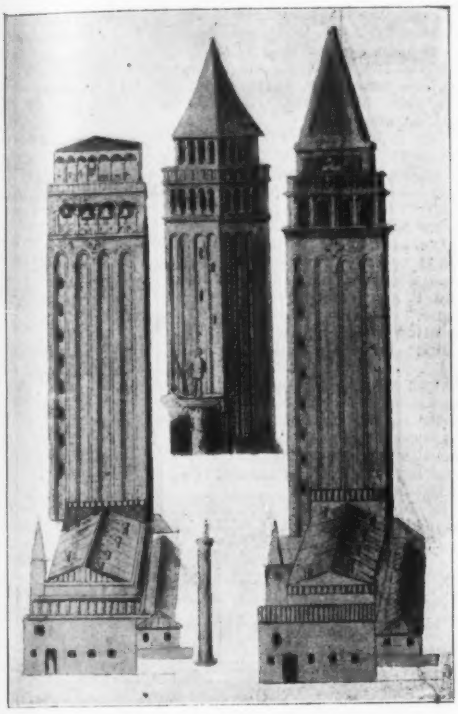




Scientific American, established 1845.
Scientific American Supplement. Vol. LIV. No. 1390.

NEW YORK, AUGUST 23, 1902.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THREE STAGES IN THE DEVELOPMENT OF THE CAMPANILE, FROM A PAINTING ATTRIBUTED TO ALBERT DURER.

VERY EARLY WOOD ENGRAVING, SHOWING THE CAMPANILE AND DUCAL PALACE.

RUINS OF THE CAMPANILE AT VENICE, SHOWING INJURY DONE TO THE ROYAL LIBRARY.

## THE RUINS OF ST. MARK'S CAMPANILE.

WE are enabled, in this issue, to give our readers a view of the ruins of the famous Campanile of Venice. This disaster, as described in a recent number of the SUPPLEMENT, is of world-wide importance, and we are gratified to learn that immediate steps are being taken to restore the venerated tower. The Campanile was begun in 888, and as first built was only 197 feet high. Later it was increased in height, but was destroyed by fire in 1489. It was then renovated by George Spavento and in 1513 the belfry was rebuilt by Bartholomew Buono to a height of 323 feet and the gilded figure of an angel was mounted on its summit. One of our illustrations shows three varied designs which the old belfry has successively assumed and now the majestic tower is but a sad heap of ruins.

Eye witnesses of the catastrophe tell us that the tower did not fall, but simply collapsed and sank within itself, and, indeed, our illustration bears out this statement, for the ruins have a circular base, instead of being spread out in any definite direction. Masses of stone from the bottom as well as from the top of the tower may be found around the edges of the heap, and the gilded angel, which was seen to descend in an upright position, fell within the portal of St. Marks. Spectators first saw lime dust issue in puffs from the tower about 20 feet up from the ground, then cracks appeared in the structure and spread upward with great rapidity, the walls bulged, the angel swayed, and with a mighty crash the old colossus sank within a cloud of dust. The beautiful little Loggetta of Sansovino, which lay at the foot of the tower, was completely destroyed, but, strange to say, St. Marks itself is not damaged in the least. The library, however, which is a most handsome and richly decorated edifice, was partly damaged. The ruined portion may be seen in our illustration.

Mr. A. Robertson, from Venice, writing in the Scotsman, gives the following causes for the collapse of the Campanile:

1. Though the walls were thick, only a few inches under six feet, they were not really solid. They consisted of two parallel walls of brick, the space, three feet wide, between them being filled up with broken bricks, rubble, cement, stones, etc. Therefore the walls were not so strong as they looked.

2. The cement used was Istrian lime mixed with sea sand. This lime does not become hard, nor does it adhere well to the bricks. Indeed, in the course of the past centuries it became dry powder. It formed the cloud that hid the falling Campanile.

3. It had become damaged by lightning, by fire and earthquake several times. On April 23, 1745, it was struck by lightning, which damaged its east side severely, killing many people in the Campanile and near it. This was its last and most serious damage, although it was not till June 18, 1776, that the republic employed the scientist, Giuseppe Toaldo, to put up a lightning conductor.

4. The republic, seeing its east side to be severely damaged, consulted two engineers of fame and ability, Signor Zandrini of Venice and Signor Polene of Padua, to examine and repair it. These engineers said the whole wall wanted support, and they proposed building a new wall against the old one. This was done. But the new wall was never properly tied to the old one. The two were practically separate, and so the weight of the Campanile was borne unequally, and its equilibrium disturbed.

5. The ringing of the bells, the firing of artillery, and only three weeks ago the simultaneous firing in the Piazza of hundreds of muskets had a tendency to disturb it; also the more or less frequent earthquakes that visit Venice.

6. Twenty years ago one of the corner pilasters of the inner wall, and precisely that at the northeast corner, was seen to be cracked in many places. The authorities of St. Mark's Church, who have charge of the Campanile, as it is the bell-tower, had this pilaster tied up. No more cracks appearing anywhere, the Campanile was thought perfectly safe, and was left alone.

7. And now comes the critical point. The Loggetta (little marble hall), built by Sansovino, rested against the eastern wall of the Campanile. It had almost a flat roof. To prevent the rain beating against the Campanile and running down its side from entering this marble hall, a row of slabs of stone sloping downward were inserted in the Campanile where the roof met it.

8. Only last week, that is, but ten days ago, these stones were begun to be removed, as the rain was somehow getting into the Loggetta, and a lead sheeting was to have been substituted. Instead of carefully removing one stone at a time, they removed half of them—that is, twenty-five feet of them. Not only so, but they dug through the new wall of the Campanile, that of 1745, and struck the old original wall, which they found separate from the new, and full of holes and cracks. While working the old wall slipped down an inch or two. Instantly the cut made was built up, but it was too late. On Wednesday, the 16th, it was observed that the new wall was cracked at the northeast corner, above the Loggetta, where the work was begun. On Thursday it enlarged. On Friday it struck across the north side of the Campanile, sloping upward to the second window from the ground, then up to the third. On Saturday it passed behind the fourth and through the fifth. On Sunday the situation was, to use the word of an engineer, "desperate," and the Campanile was doomed. On Monday the crack visibly opened while we watched it, and the end came in a moment, when the whole structure sank into itself.

Now for the responsibility. Who was responsible? First, the engineer of the Campanile is Signor Saccardo, who is the engineer of St. Mark's Church. But Signor Saccardo is not the engineer in charge of the "marble hall," the "Loggetta" of Sansovino. That is under the charge of the authorities who take care of other national monuments in Venice. Secondly, these authorities in repairing the Loggetta roof, for which they were responsible, cut into the Campanile, as we have seen, as one might cut into a tree they intended to fell, and this they did without consulting Signor Saccardo, who bears the care of the Campanile.

The cutting they did, had the Campanile been in good condition, would have had no effect upon it, but as things were, it was the last straw that broke the camel's back.

In 1892 Luigi Vendrasco made a report on the Campanile, representing it as standing in need of immediate repair. He was not listened to. When the Campanile fell Vendrasco left Venice broken-hearted. Minister Nasi has sent for him, but he refuses to come, saying, "I cannot save the Campanile now. I can only incriminate others, which I refuse to do. I decline to take part in the inquest."

Signor Vendrasco, with his son, was at the Campanile at 5 o'clock on Monday morning. He showed his son the crack. The son said, "Father, I do not see how that crack can imperil the Campanile. Perhaps that corner will fall." "No, my son," answered the father, "they have cut the Campanile across. It will not see the sun to-day in its zenith. The Campanile will fall in a few hours, and it will not fall across the Piazza; it will simply sink into itself." And this it did at 9:50.

During all these days of peril nothing was done to save the precious bronze statues, the bronze doors, the marble carvings that were in the Loggetta. These could have been all removed. Nothing was done to save human life. The Campanile was felled like a giant oak, and people were not even warned to keep from under it.

## THE FIRST MAGNETICIAN.*

"THIS booke is not for every rude and unconnynge man to see, but for clerkys and very gentylmen that understand gentylness and scyence."

This quotation from Caxton is prefixed by Prof. Thompson to his notes to the new edition of the "De Magnete."

Most students of electricity know that William Gilbert, of Colchester, is the father of the sciences of magnetism and electricity. They may have some idea of the extent of his discoveries and the general character of his work, but few who have not seen the celebrated book in which he recorded his results can have really grasped how much Gilbert knew and how thorough and complete were his investigations.

"He practised the experimental method of observation before Bacon wrote about it; his methods and discoveries excited the sneers of Bacon, the praises of Galileo and Kepler."

The book justifies the high claim put forward on its behalf by its latest editor, and the thanks of men of science are due to him and to all who have helped him for enabling them to learn what Gilbert did.

It was a happy thought to found the Gilbert Club, and the members of the club who have the chance of possessing this splendid volume, the outcome of many years of patient research and loving labor, are greatly to be envied.

The club was founded in 1889 to commemorate Gilbert's work and to issue a translation in English; at the date there was none, though one was published in America in 1893. The original edition was issued in 1600, and it was at first hoped that the translation might be ready in time for the tercentenary celebration at Colchester in 1900. This proved impossible, but the work is now complete and the result is admirable.

It will be of interest here to give a brief account of the work itself. Starting with the early history of the loadstone, its power of attracting iron known to the ancients and its property of setting in a definite direction discovered in the tenth of twelfth century, Gilbert in the first book of his treatise sets forth the various fundamental properties of a magnet and of magnetized iron, illustrating them by the experiments now familiar to all, and describing almost in every chapter some new discovery or some important law. He is continually appealing to experiment and accurate observation. "Deplorable is man's ignorance in natural science," he writes, "and modern philosophers like those who dream in darkness need to be aroused and taught the uses of things and how to deal with them, and to be induced to leave the learning sought at leisure from books alone and that is supported only by unrealities of arguments and by conjectures." But Gilbert lived too early; it was more than 200 years before the truth of his maxim was realized.

He was quick to appreciate at their true value the inaccurate observations of some who had gone before him.

"Albertus Magnus writes," we are told, "that a loadstone had been found in his day which with one part drew to itself iron and repelled it with the other end; but Albertus observed the facts badly; for every loadstone attracts with one end iron that has been touched by a loadstone and likewise drives it away with the other."

Among other things, we may note his observation that "a long piece of iron (even though not excited by a magnet) settles itself toward north and south;" but perhaps the greatest discovery in this book is contained in the last chapter, "That the globe of the earth is magnetick and a magnet," our "New and unheard of doctrine about the earth" he calls it. The doctrine is proved by the observations and experiments which are the subject of the rest of the treatise.

Book II. deals with a number of examples of magnetic attraction, and in Chapter II., "On the magnetic coition, and first on the attraction of amber, or more truly on the attaching of bodies to amber," we find the beginnings of the theory of electricity. "For in other bodies," he writes, "a conspicuous force of attraction manifests itself otherwise than in loadstone; like as in amber, concerning which some things must first be said that it may appear what is that attaching to bodies and how it is different from and foreign to the magnetical actions, those mortals being still ignorant who think that inclination to be an attraction and compare it with the magnetic coitions," and so to illustrate electric actions he invents the straw electroscope. He divides bodies into "electricks," which are electrified by friction and attract light bodies, and "non-electricks," the metals and other conductors as we now call them. The effect of heat and moisture is studied and described, and the distinction between electrical and magnetic attraction has been fully made out.

With amber or other "electricks," "if indeed either a sheet of paper or a piece of linen be interposed there will be no movement. But a loadstone without friction or heat, whether dry or suffused with moisture, invites magneticks, even with the most solid bodies interposed, even planks of wood or pretty thick slabs of stone or sheets of metal. A loadstone appeals to magneticks only, towards electricks all things move."

He has no mercy on those who would make a perpetual-motion machine by means of the attraction of a loadstone.

"But they have been little practised in magnetick experiments who forge such things as that. . . . Oh that the gods would at length bring to a miserable end such fictitious, crazy, deformed labors with which the minds of the studious are blinded."

Book III. is on Direction, the property of the magnet to point north and south. At the outset Gilbert recognizes that the compass needle deviates from the true North Pole by an amount which varies at different points on the earth. "But it must be understood," he says, "on the threshold of the argument (before we proceed further) that these pointings of the loadstone or of iron are not perpetually made toward the true poles of the world, do not always seek those fixed and definite points or remain on the line of the true meridian, but usually diverge some distance to the east or west."

The fundamental laws of the magnetization of iron by contact with another magnet, by induction, either from a loadstone or in the earth's field, are clearly set out. Gilbert knew, too, how to demagnetize a magnet. "Putting the whole iron in the fire," he writes, "blow the fire with the bellows so that it may be all aglow and let it remain a little longer time red hot. When cooled (so, however, that while it is cooling it does not rest in one position) . . . you will see that it has lost the verticity it had acquired from the stone." Verticity is the name given to the property of pointing north and south.

Book IV. deals with "Variation," the angle between the true and magnetic meridian at any point, and though we cannot agree with Gilbert that "the variation is caused by the inequality of the projecting parts of the earth," or that "the variation in any one place is constant," we can admire his skill and resource in utilizing the scanty material at his disposal and in devising methods to measure the amount of the variation.

In Book V. the action of a dipping needle is described and explained, while Book VI. treats of the "Globe of the Earth the Great Magnet."

Any notice of this edition of the "De Magnete" would be incomplete without some reference to the notes contributed by the editor.

During the work of revising and editing the English translation of "De Magnete," many points, as Prof. Thompson writes, came up for discussion requiring critical consideration and the examination of the writings of contemporary or earlier authorities. The results of some portion of this labor have been collected in the form of notes. The text has with great judgment been printed just as Gilbert left it; in fact, comparison shows that throughout the English and the original Latin versions run page for page. The notes cover some seventy pages, and are replete with curious and interesting information. It appears that woodcuts containing human figures are rare in the art of the sixteenth century, and Prof. Thompson traces Gilbert's picture to a book of fables by Cornelius van Kiel, published at Cologne in 1594, where it is used to illustrate a fable of the blacksmith and his dog. The dog has been omitted in the Gilbert picture, the words Septentrio and Auster have been added and some other details modified, but there is no doubt where the picture came from.

Another note of interest is that to p. 165, dealing with the discovery of the mariner's compass, its construction and the wind-rose or chart of the winds marked on the card of the compass. The earliest known examples of the wind-rose are on certain Venetian charts dating back to 1426 or 1436. Not less interesting is the paper which some five years since Prof. Thompson read before the Bibliographical Society on "Peter Short, Printer, and His Marks." This, however, is not in this volume. Peter Short, the hitherto unknown printer of the book, used as his mark the device of a serpent entwined round a T-shaped support, and the investigation as to why this mark was used has led to a most interesting chapter in the history of the printers of the sixteenth century.

But enough has probably been said to convince even an unwilling reader of the value of the book "De Magnete" and of the services which the editor and his colleagues have rendered to science by the issue of this English edition. They are to be congratulated on the results of their labor of love, which, though it has cost them many hours of toil, has had so successful an issue.—R. T. G., in Nature.

* William Gilbert, of Colchester, Physician of London, on the Magnet, Magnetic Bodies also, and on the Great Magnet the Earth." Pp. 246. Published in Latin, 1600. Translated and edited for the Gilbert Club, 1900, with notes by Prof. S. P. Thompson, F.R.S.

## SPENCER'S CURE FOR GARRULITY.

IN a little essay entitled "Some Questions," Herbert Spencer suggests a mode of obtaining relief from the talkative person. He tells us that while in the south of England for his health he was usually accompanied in his daily drives by two ladies whose incessant conversation even the long-suffering Socrates could not have borne. Spencer checked this strain of irrelevant talk by asking questions which could not be answered without some thought. Thus, he tells us, he acquired his habit of setting problems, partly by way of gaging the knowledge of young people, and partly by way of exercising their reasoning powers. One of his simplest inquiries was: "How happens it that sheep, rabbits and hares have their eyes on the sides of their head, while cats and dogs have their eyes nearly in front?" Other questions are: "How is it possible for a lark while soaring to sing for several minutes without cessation?" "Why is it that in hilly districts the roads are deep down below the level of the fields,

whereas in flat districts they are on a level with the fields? Throughout the country, especially in its less frequented parts, the by-roads and sometimes even the main roads have strips of greensward several yards wide on either side of the part used for traffic. In what manner did these strips originate?" "Cows and horses drink in the same way that we do, whereas dogs and cats drink by lapping. Whence arises this difference of habit?" "Why does a duck waddle in walking? And what is the need for that trait of structure which causes the waddle?" "How is it that a bulldog is able to retain his hold for a longer period than other dogs?" Again Spencer used to ask: "Rookeries are nearly always close to human dwellings, usually always at some side. Rooks seem to gain nothing from this proximity, but daily fly far away to their feeding grounds. Moreover, they persist in thus breeding in the trees around houses, though annually many of their young are shot as soon as they can fly. What circumstances have led to this establishment of a home apparently so unfit?" In rambles and drives throughout the country we see few blackbirds or thrushes in the open fields, but we see more as we approach houses, especially good houses, even in parts of the year when there are no temptations from the fruit gardens. Why is this?"

Spencer says that the attempted answers to these questions, besides being startling, generally betrayed no conception of a relevant cause. Sometimes answers were suggested which even though relevant were utterly indefinite. And from all this Spencer concludes that a mind in such state would be a seedbed for superstition.

## PURIFICATION OF DRINKING WATER BY OZONE ACCORDING TO THE SIEMENS & HALSKE PROCESS.

For three years the firm of Siemens & Halske has been conducting experimental ozone water-works erected on their grounds at Martinikenfelde, near the river Spree, in the city of Berlin. They have had the assistance of specialists well versed in the principles of hydrodynamics and hygiene, and have sought to test the practicability of the use of ozone for the purification of drinking water under conditions inseparable from a public establishment. They have examined primarily the sterilizing effect of ozone upon the bacteria of surface water, one of the most important points for consideration. The means for eliminating iron and coloring matter by the agency of ozone have been studied by them, both at Martinikenfelde and at the city of Königsberg. The cheap methods hitherto employed for this purpose by evaporating and spraying are attended with great difficulty and are not effective. The ozone employed for their experiments was produced from the air by means of electricity by the so-called silent discharge. The air, according to the type of the apparatus, was either not dried, or partly deprived of its humidity by well-known drying apparatus (small ice-machine, sulphuric acid, calcium chloride, or introduction into cold, deep well-water). The Siemens' newly-constructed or plate apparatus was used, either without condensation or condensation by electrodes through a system of pipes. It is characteristic of this apparatus that the discharge chamber or space through which the air passes, is in one case bounded by horizontal parallel plates (plate glass covered with tinfoil on the outside, and below metal plates resistant to ozone); in the other case by concentric pipes fitted in each other, and arranged vertically (mica covered with tin foil on the outside, metal cylinder cooled by water inside). This apparatus, which carries an alternating current of 8,000 to 12,000 volts, gives from twenty to twenty-five grammes of ozone per horse power hour, with a concentration of ozone of three grammes per cubic meter of ozonized air. For absorption, columns of masonry filled with pebbles are employed. By previous quick filtration the water is cleared of floating substances; it then runs through the pebbles in fine streams, meeting in a counter current the concentrated ozone-air ascending from below. The water submitted to these attempts at sterilization in Martinikenfelde has been water of the river Spree or a mixture of two-thirds Spree and one-third aqueduct water, of very bad bacteriological and chemical quality (degree of oxidation 3.76 or 14.9 permanganate). The sterilization of ten cubic meters of water, a quantity sufficient for a day's supply of drinking water for a town of 4,000 or 5,000 inhabitants, has been effected in an hour. The bacteriological and chemical results, according to the formal reports, are the following:

(*a*) Bacteriological: Although the water for the experiments was very bad, containing from 100,000 to 600,000 germs to the cubic centimeter (having to pass first through a quick filter, patented by Kröhnke, to be cleared of floating substances), yet in most cases the ozone sterilization was complete; in no case were more than from two to nine germs per cubic centimeter found remaining. Water containing 100 germs per cubic centimeter is still practically admissible for use in water-works. The few isolated germs still subsisting belong to a group of bacteria which are very resistant to means of sterilization, such as earth and root bacteria, and the hay bacillus. These are not of a pathognomonic character.

(*b*) Chemical: The degree of oxidation of the water (quantity of oxidizing organic substances, demonstrated by the solution of permanganate), was by ozone treatment reduced 18 per cent. At the same time the ozonized water, tinged by organic substances or by ferric oxide, was entirely cleared of the coloring matter. The amount of air was increased by ozone treatment from 10 to 12 per cent and the oxygen from 36 to 39 per cent; there was no increase in nitrogen. The water thus treated and devoid of color and taste exhibits no trace of ozone, so that there is no danger of the oxidation of reservoirs and pipes. The consumption of ozone per cubic meter of sterilized water amounts to two grammes.

An establishment of this kind can turn out per hour from 120 to 150 cubic meters of sterilized water, at a cost, including labor, interest and all expenses, of 5.031 pfennigs per cubic meter. The cost of such an establishment would be about 60,000 marks.

The illustration represents the arrangement of the experimental apparatus in Martinikenfelde. It consists of three parts:

1. The contrivance for quick filtering, patented by Kröhnke. An iron cylinder is mounted on a revolving shaft, in the interior of which are two perforated parallel iron plates; between these well-sifted sand, not too fine, is poured in, and the water is driven through by the pressure resulting from the difference in the level of the water in the reservoir above. Whenever the sand becomes too muddy, the revolving axis is turned by a winch; the sand is shaken and by rinsing for about 10 minutes with water flowing in the opposite direction, is washed, and the filter is again ready for its work. In this way the water of the River Spree, after flowing through the city of Berlin, is freed from its impurities.

The sterilization tower is a structure of masonry, cemented in the interior, five centimeters in height; it is divided into two chambers by a strong iron grate placed in the lower part of the tower. The upper compartment is for the ozonization; the lower compartment contains the ozonized water, and by a discharge opening on one side, very near the bottom, is connected with a chamber, which forms at the same time a receptacle for the surplus water and causes the current of ozone, instead of passing through the tower, to go out into the air. The upper compartment is several meters high, filled with pebbles as large as a fist; here the filtered water by means of sprinklers and sieves beats in a fine rain on the surface of the rocky layer and runs downward, divided in many little streams, presenting a large surface to the ozone current coming from the opposite direction.

Adjoining the tower is the surplus receptacle mentioned and also the principal reservoir for the sterilized water, ready for use.

The air chamber of the ozone part of the apparatus has plates arranged for the silent electric discharge. In a hermetically closed compartment of resistant metal or other material, four or more connected couples of plates are placed parallel to each other and the dry air to be ozonized is driven under slight pressure with moderate velocity through the discharge chamber. A window in one side of the compartment allows of observation.

In order to determine with greater certainty the effect of ozone on the removal of iron, experiments were instituted on water containing a large quantity of ferric oxide. Limited tests of this kind were made at Martinikenfelde, and afterward larger operations at the city of Königsberg, with the co-operation of the experienced members of the water administration of that city. It became obvious that the metallic salt, very difficult to eliminate by present methods, is easily separated from the water in the form of hydrated ferric oxide in a state that can be well filtered. The water for these experiments had a degree of oxidation of 4 to 7.5 per cent and contained a large number of bacteria. The consumption of ozone per cubic meter amounted to from 3 to 3.5 grammes. The decrease in the degree of oxidation was from 18 to 20 per cent. The quantity of oxygen, which in these different tests was from 0 to 7.5 liters per cubic meter, increased by the ozone air treatment to 8 or 10 liters per cubic meter.

The ozonization of the water to be cleared of iron oxide was performed in two stages, first, by spraying in an Oesten tower* furnished with a quick sand filter; secondly, in an ozone tower filled with pebbles, placed back of the Oesten tower. The ozone air entered first the tower filled with pebbles, and the ozone, which was not taken up here, passed to the front into the Oesten spray. However, a tower filled with pebbles having a quick sand filter placed back of it, likewise produced the desired effect.

Only constructions of a simple kind, easily supervised, ought to be used for ozone water-works, so that the persons in attendance may be able without trouble to control them continuously. The ozone apparatus, for instance, should be built in such a way that the electric discharges, which take place inside, may be directly visible. To secure, however, the perfect control of the works by attendants, to make assurance doubly sure, some simple arrangements have been perfected, by which in case of a disturbance in the works, not only acoustic warning signals are given, but the water is automatically shut off. Any kind of accident in any part of the electric apparatus would be noticed at once by the sudden stoppage of the electric current connected with the ozone apparatus. In such a case, an electro-magnet held by the current, falls and sets to work the alarm signal and the contrivance for the automatic shutting off of the water. The water and air pipes are so well arranged that disturbance in them is not to be expected.

The management of water-works of this kind is not difficult. As soon as it is evident that the water to be disinfected has absorbed a certain quantity of ozone, there is absolute certainty that the bacteria contained in it have been destroyed. It is only necessary to determine whether the water leaving the tower gives the well known reaction of ozone (starch paste solution of a certain degree of strength). The test may be easily applied, even by persons without previous practice, as the only thing to be done is to compare the blue color in a glass filled with reagents of the standard solutions. Tests of this kind can be effected in a quarter of an hour, while, it is well known that, by examining water for bacteria in sand-filter water-works, only after from two to four days can it be determined with certainty whether the samples are really well-filtered water.

Men practically interested in water-works have endeavored to procure for drinking purposes deep well water, which is free from bacteria. So, the purification of the surface water may not have for some communities the importance it would have had years ago. Still, the ozone treatment judiciously joined to quick filtration, is destined to keep its place as an efficient method for converting surface water into good drinking water. It has left the stage of laboratory experiment and has become technically complete in regard to precision of work and economy.

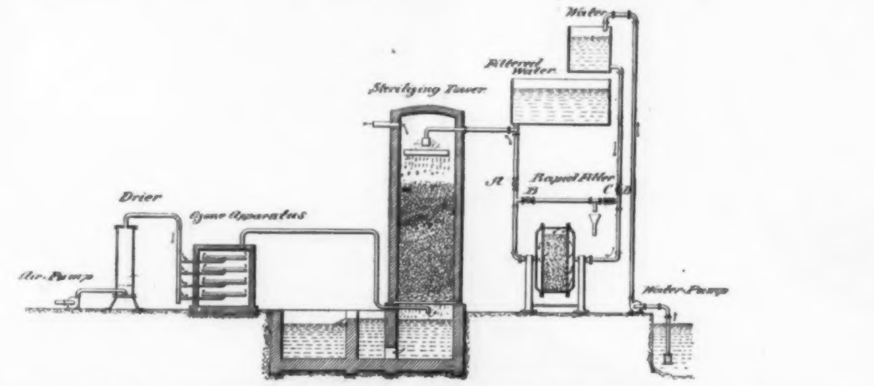
The electro-chemical ozone treatment is the only chemical treatment by which nothing detrimental to health is introduced into the water, and no products are engendered which affect its taste and odor. This treatment will be applied:

(*a*) Principally, as an additional treatment, for instance, as a means to increase the working capacity of establishments for filtering water in order to destroy bacteria, when local enlargement is very difficult; a part of the slow filters on hand may be set to work as quick filters, and the filtered water may afterward be subjected to the sterilizing effects of ozone.

(*b*) in cases where the problem is to remove from the water the organic coloring matter, which in the usual course through a filter is not eliminated, or to obviate the moldy odor which a good deal of water, in spite of filtration, retains in the hot season.

In regard to deep wells, properly conditioned, the ozone treatment to sterilize the water is of course not needed; but it is doubtful, whether by the air alone all the organic iron salts can be removed from the water.

For deep wells, however, where an inflow of surface water may be apprehended either by infiltration or by subterranean communication with streams, the ozone treatment can be recommended, for it would be a delusion to consider deep wells of this kind any safer with regard to hygiene than the usual surface water works.—Compiled from an article in Schilling's Journal für Gasbeleuchtung und Wasserversorgung.




APPARATUS FOR PURIFYING DRINKING WATER BY THE USE OF OZONE.

* Named for a Berlin Engineer.

## WHAT THE MICROSCOPE HAS DONE.

I remember that in the year 1860, says Prof. John Trowbridge, in the Atlantic, a man who occupied himself with a microscope was smiled at as a blear-eyed, narrow specialist, who had little interest in the large affairs of humanity—in the important questions of the time, such as the anti-slavery cause, the question of the Turk, the problems of free trade and the tariff. It was supposed that the microscope was a perfected instrument, and that little more could be done with it than in studying lower forms of life, which were interesting to the naturalist, but had little to do with humanity. At that time the death rate from diphtheria was over 60 per cent, and more than 5 per cent of women died in childbirth. To-day, owing to improvements in the microscope, the death rate in diphtheria has been reduced to less than 10 per cent, and the mortality in lying-in cases to one twentieth of 1 per cent.

Zeiss has perfected microscope lenses which have made possible the study of bacilli, and have led to some important results in the treatment of disease. Modern aseptic surgery is the result also of investigations with this new instrument of research.

Thus the improvements in the microscope have led to the germ theory of disease, the discovery of antitoxin, and to that greatest boon to mankind of the century just closed, the realization of the importance of aseptic surgery. In aseptic surgery the endeavor of the surgeon is to exclude the small germs which vitiate the blood, and the result of the study of electric discharges is now leading to methods of communicating electrons to the tissues or to methods of setting them free. Violet light can set free electrons from metals. X-rays can do the same. Moreover, the latter can burn the tissues, setting up some yet obscure form of electrolytic action. It is claimed strenuously by good authorities that there is a healing action in malignant skin diseases, due to this new electrical radiation.

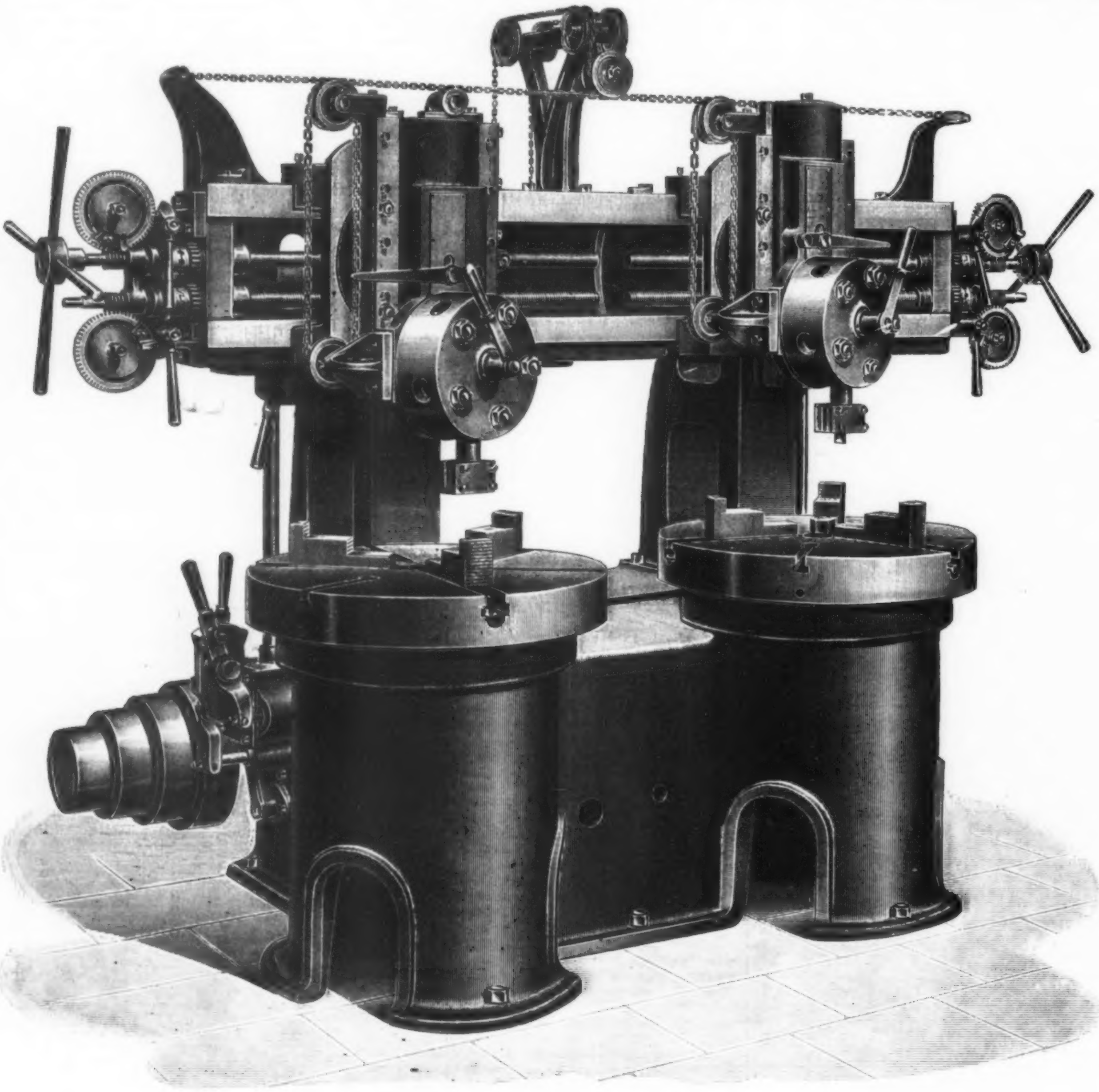
## DOUBLE BORING MILL.

One of the advantages which the smaller boring mills possess over the lathe—an advantage which can hardly be denied by the stoutest advocates of the older machine—is the possibility of making them duplex or even multiplex. Of course, we have double lathes, and double boring machines are very common and economical. The mill, however, lends itself more kindly to this treatment than the lathe, and several excellent types are extant. Probably Webster and Bennett, of Coventry, have given the question of compound vertical tools as much attention as any one in this country. They have recently completed the double boring and turning mill, which is illustrated herewith, to entirely new designs. The machine consists of two tools with one common body, but in all other respects quite independent. Of course, one operator looks after both sides.

The chucks or tables are driven by large spur gearing, which has a pressure ring running in oil to take the down thrust. The spindles are of large diameter, and the bearings are adjustable for wear. The driving cones take wide belts, and the power is still further supplemented by double purchase gearing, thrown in or out of action by moving handles at the front of the machine. The turrets are bored to receive the tools, which are securely clamped in position. The driving mechanism is of steel and hardened. Both turret slides are fitted with indicated swivels for taper boring or turning. A positive stop is fitted to set each turret central with its chuck when boring. All the feed motions, vertical, angular, and horizontal, are automatic, positive, reversible, and self-stopping.

The feeds of the two turrets are in every way independent of each other. The trip motions are simple in their action, and work when the direction of any feed is reversed. They are of the same design as that illustrated in our issue of October 4 last, when a smaller machine of the same kind was described and illustrated by engravings and drawings. The trip dials are marked in eighths of an inch. The rate of feed is changed by the movement of a lever. The turret slides are balanced to allow of easy manipulation. All gears are cut from the solid blank.

The principal dimensions are: Diameter of chuck, 30 inches; diameter of turret, 12 inches; diameter of turret holes, 2 inches; number of turret holes, 5; automatic travel of turret, 16 inches; maximum height, table to turret, 22 inches; height, table to cross slide, 16 inches; number of table speeds, 16; number of rates of feed, 6; four-speed cone, 14 inches to 8 by 3½ inches belt; size of fast and loose pulleys, 14 inches diameter by 3½ inches belt; revolutions per minute, 180 and 300; floor space occupied, 10 feet by 5 feet 3 inches; approximate weight, 4½ tons.—The Engineer.



DOUBLE BORING MILL.

## EFFECT OF PROPELLER PITCH ON SPEED.

With a view to obtaining definite information as to what effect the pitch of a propeller has on the speed of a vessel, the Admiralty are making comparative trials with the four ships of the "Drake" class. In all these vessels the propeller is the same, and is that evolved as the result of tank experiments; but the blades, being bolted to the boss, can have their pitch varied so as to increase or decrease the coarseness. On the trials of the "Drake," where the pitch was 24 feet 6 inches, the speed of 23.05 knots was got with 116 revolutions; whereas in the case of the "Good Hope" the same speed necessitated the engines running at slightly over 126 revolutions, because the propellers had a pitch of only 22 feet 9½ inches. The "Leviathan" represented the medium course; her propellers, having a pitch of 23 feet 9½ inches, gave the ship a speed of 23.25 knots with 122 revolutions; and it is now proposed to see what results will be got from the fourth ship of the class, the "King Alfred," now lying in Portsmouth Dockyard, by still further increasing the pitch of her propeller. The slip of the propeller was least in the case of the "Drake," but this does not hold good in the trial at four-fifth power; when the speed was 22 knots, the "Drake" on her full-power trial developed 30,557 horse power when running at 116 revolutions, and then the coal consumption was 1.83 tons per horse power per hour. On her 30-hours' trial at 75 per cent of the power, 106 revolutions gave 23,103 indicated horse power, the speed working out to 22.08, which is practically the same as in the case of the "Good Hope." The coal consumption was 1.8 pound. On the low-power trial at one-fifth the maximum speed proved to be practically 15½ knots for 6,937 horse power, the revolutions being then 72 and the coal consumption 1.72 per horse power per hour.

## THE MODERN BESSEMER PLANT.

No industry has been more ready to recognize the merits of general discovery, or quicker to reap the benefits of new devices, than the manufacture of iron and steel, and a well-equipped plant is to-day the very embodiment of applied science. As we compare former types, it is patent that our present practice is essentially based on the underlying principles of a quarter of a century ago. The blast-furnace, the converter, the open-hearth furnace, and the rolling mill are still the agents of reduction and conversion. But here similarity ceases. Manual labor has been largely replaced by machinery; empiricism has given way to exact methods; tonnage has increased enormously, and products have been greatly diversified and cheapened.

It is not easy to concisely compare the old with the new, but for measuring the changes of the last three decades we can, perhaps, find no better yardstick than the steel rail. Its manufacture was not only the most important immediate result of Bessemer's discovery, but still affords the largest individual tonnage of any of the steel products.

The refining of the iron at the converter by the combustion of its own impurities is dramatically picturesque, and in comparison with the operation of twenty-five years ago presents a most striking example of the effectiveness of modern methods. At that time 200 tons a day represented a large output. To-day a modern mill produces as much in twelve hours' time as the old one formerly turned out in a week. The increase in the number and size of the vessels, greater blowing power, and intelligent application of hydraulics and electricity all have had their share in this metamorphosis. The casting pit has given way to the pouring of steel direct upon cars, and the man with the sledge, struggling with the ingot that would resist parting with its mold-embrace, has been supplanted by vertical hydraulic rams that strip the ingot and remove the molds with ease and dispatch. These are some of the elements that account for the increase in production from 5,000 tons to 85,000 tons a month and have caused the average efficiency of converting mill labor to become six times as great as it was under the old regime. As measured by the average results, one man now does as much work in the conversion of steel as six men did a short generation ago.

## A CITY FUEL OIL PIPE SYSTEM.

Delivering fuel oil to houses and factories just as gas and water are delivered now, through pipe systems, is one of the schemes which is said to have been prompted by the latest oil discoveries in the United States. According to report, a purchase offer has been made for one of the city water works with the view of closing it for water purposes and reopening it for the oil business. The present reservoir, which will hold about 20,000,000 gallons, is to be converted

into an oil tank, and the mains are to be used for carrying the oil at a minimum cost to consumers. It would only be necessary to turn on the water cock to get as much oil as a consumer needed, and a meter would keep account of the amount supplied, thus affording, it is thought, the most perfect system of fuel oil distribution in the world. The oil would be pumped from one of the oil fields to the reservoir, and from this, by natural pressure, without further pumping, it would be distributed to all the points of consumption in the city. With the reported money interests backing the project, this would seem to be entitled to rather more than passing consideration.—Cassier's Magazine for April.

## PLATINUM DISCOVERIES.

ONE of the rarest metals in the world is platinum. It is the only metal that can be used for making many a piece of chemical apparatus, because it resists the corrosive action of acids. In the past few years the price of the metal has been steadily increasing, for the reason that the demand has greatly exceeded the supply. The chief source, the Ural Mountains, furnishes only about six tons a year, which have been sold at prices varying from $150 to $170 a pound.

Recent discoveries have been made that point to the existence of platinum on our own continent. The New York Sun says that a supply of platinum has been discovered at two places in Washington, near Princeton and at the Olympia mine on Kennedy Mountain. Specimens of this ore taken from the Olympia mine were sent to a firm manufacturing platinum wares at Newark, N. J. The firm tested the ore and reported that it contained platinum in commercial quantities.

This firm wrote to Washington asking for information as to the probable amount of platinum available. On account of deep snow it was impossible to make other researches during the winter, but the ground near where the finds were made has been staked and the claims will be thoroughly investigated this spring.

In December last the Dominion government sent an expert to the Klondike to investigate the platinum discoveries reported to have been made there. The expert was sent on the strength of a report made by C. S. Hurter, a government metallurgist, who reported that in the Yukon gold brought to him last year was a considerable quantity of platinum, whose presence the miners had not discovered. Many very small nuggets of platinum were mixed with coarse gold. Mr. Hurter gave it as his opinion that the miners of the Yukon were throwing away thousands of dollars' worth of platinum daily.

The amount of this metal produced in the Ural region is quite variable. In 1890 the yield was 6,363 pounds, while in 1899 it was 13,242 pounds. For several years the average production has been about 12,000 pounds. It will be a great boon if the metal found in our own country and Canada proves to be in commercial supply, for the price is now excessive, and it is most desirable that the output be augmented.

## AN EXPERIENCE IN A GASEOUS MINE.

REMINDED of some of his own experiences by the recent disaster in the Cambria Mine, Frederick E. Saward, of the Coal Trade Journal, gave the following account of phenomena in a gaseous mine:

"I had been invited," said he, "to visit a property which was said to possess a seam of coal of unusual thickness and purity. It was, nevertheless, a notoriously gassy mine, insomuch that the fire boss made regular rounds to test the working places and chalk up warning signs if too dangerous vapor was discovered.

"Going down a 300-foot shaft on a platform elevator without sides (simply the guide rods), in company with the fire boss, I walked along the main entry for one-half a mile, viewing the coal by the light of our little tin-cup lamps. Presently, on approaching a visibly cracked roof, my guide said that he would show me what gas was and how it was put out. He held his lamp up near the crevice in the roof, and forthwith there was a floating of blue gas along the roof near the crevice, like burning alcohol in a basin of water.

"'We will not let it get ahead of us,' said the guide, and with that he took off his coat and brushed out the flaming gas, driving it away from the crevice. If he had driven it toward the crevice, the roof might have come down. As if this were not enough, the guide said: 'I will show you where it is not even safe to go with an ordinary lamp.' He thereupon lit his safety and blew out the other tin-cup lamps. We walked along the entry until we came to a place which led up the face of the coal. Climbing upon that which had been broken down, the guide lifted his safety lamp and the blue flame began to dance around the gauze.

"This daily tour of the fire boss no doubt saves many lives, but there is often a quick accumulation in places where he has found nothing dangerous."

## OCEAN'S MANY MICROBES.

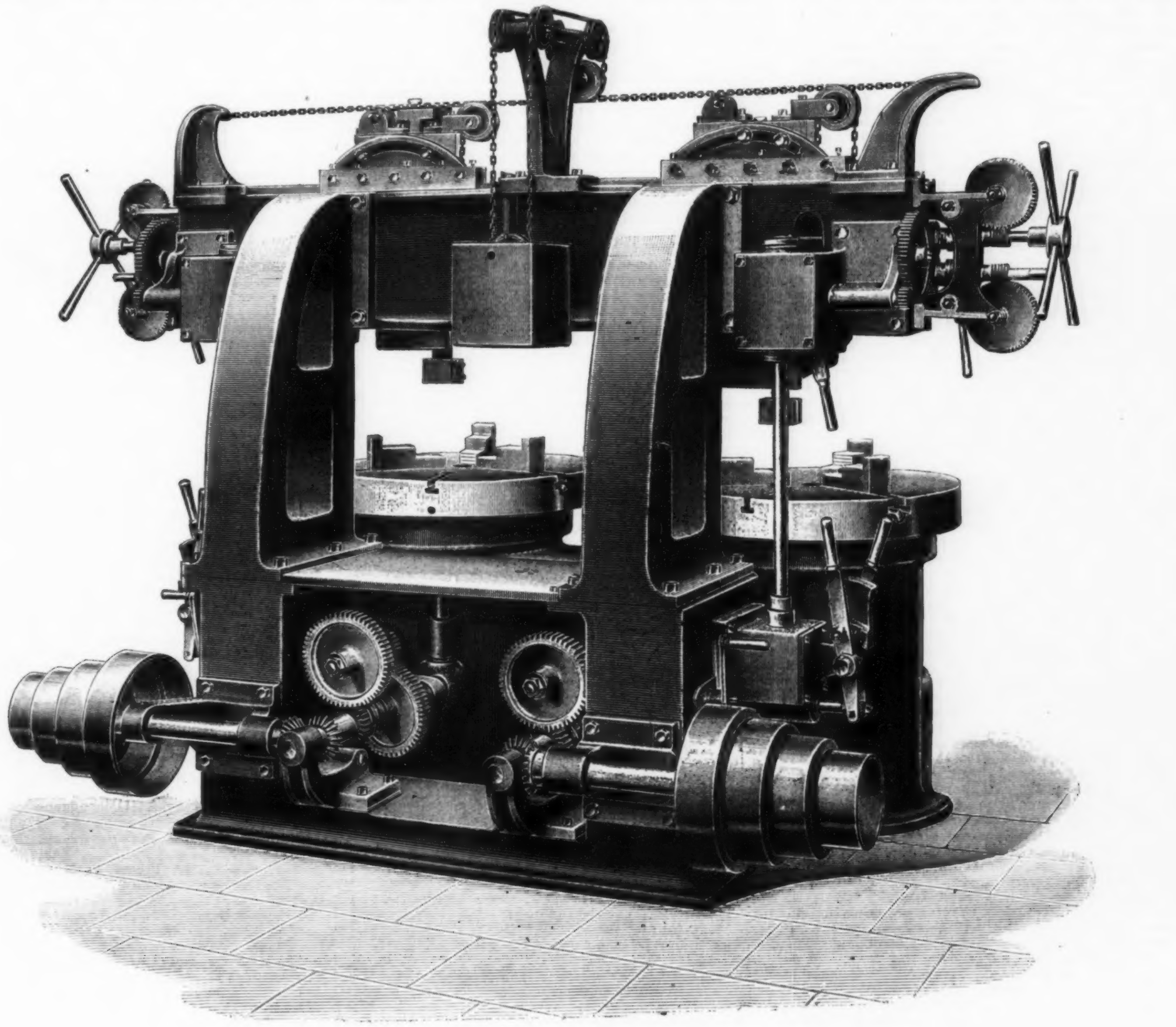
AT no particular spot has the sea been found to be free from organisms, although those isolated and recognized have proved to be harmless, consisting of active motile rods and vibrios, cocci being less numerous. As might be expected, the number of organisms increases immensely as the shore is approached. Thus about a mile from the shore something like 4,000 germs per cubic centimeter have been found, and this influence of the shore extends for four or five miles. Some hundreds of miles from land the number diminishes to 600 and at greater distances to 200 or less.

Of course, the fact that algal vegetation is richest near the shore, providing a highly nourishing hunting ground for the marine organism, accounts for the myriads usually found there. Samples of sea water taken at some depth below the surface proved to contain only a few bacteria per cubic centimeter. Thus at half a mile below the surface only from eight to twelve bacteria were present. There is little doubt that even should pathogenic organisms gain access to the sea, as must be the case when sewers discharge raw sewage into it, their activity must sooner or later be destroyed.

The sea is remarkable from a bacteriological point of view in containing phosphorescent bacteria, and it is probable that some of these are disease producing, so far, at any rate, as regards certain aquatic animals. Thus a bacterium has been successfully cultivated from the body of the luminous talitrus which is both pathogenic and luminous. This bacterium invades the abdominal cavity of this aquatic animal and all its organs with a fatal issue. During the presence of the disease the victim shines with a green light, which is said to be visible nearly a dozen yards away and which persists for some hours after the demise of the animal. It is not improbable that the luminosity of other marine animals may be due to the invasion of this light and disease-producing organism.

The very beautiful phenomenon of the phosphorescence of the sea is caused by photobacteria in part as well as by a variety of low forms of animal life. The eerie light is in no way connected with the element phosphorus, as is very commonly supposed. The cause of the phenomenon is respiratory exchange or oxidation, an aerobic function. Sea phosphorescence is never witnessed in perfectly smooth water, while the brilliancy of the light when it is observed is always greatest upon the crests of the waves or where the water is in a violent state of agitation, as in the wake of a steamer. Its occurrence, therefore, is evidence of active oxidation. Could, again, the sea be sterilized phosphorescence would cease.

The presence of highly combustible matter increases the light. A very simple experiment proves this. If the flesh of a fresh haddock or herring be placed in a 3 per cent salt solution and kept at a low temperature (from 40 to 50 deg. F.) the liquid will rapidly develop phosphorescence, which becomes quite brilliant on adding a little glycerine or sugar, or what, in other words, is respirable material. It is curious that in marine life disease and death should be associated with luminous phenomena.—The Lancet.



DOUBLE BORING MILL.

## THE ROLE OF MOSQUITOES IN THE DISSEMINATION OF DISEASES.

By A. DASTRE.*

HAVE we returned to the time in which Reaumur interested not only scientists, but also ordinary folk, in the natural history of gnats, and in which his thirteenth memoir, devoted to a description of these little animals, their larva and their pupa, and to an exposition of their customs and habits, found readers both in the city of Paris and at Court? One might think so to witness the eagerness of the public of to-day for everything that is said about mosquitoes at the Academy of Medicine or in scientific societies. But it is easy to see that it is not a disinterested zeal for the natural history of these little insects that is exhibiting itself at present. Our dearest interests, our health and our very life are at stake. We have discovered that mosquitoes are injurious to a far greater extent than we had supposed. They are not only an unwelcome, troublesome, insupportable and exasperating pest, but also a formidable enemy whose habits must be well known in order that we may combat them scientifically. They are the transmitting agents of some of the most dread affections that man has to suffer in warm countries—paludal fever, filariosis, yellow fever, and perhaps lepra.

I.

Gnats and mosquitoes are the names employed in common language to designate these insects, which are very similar, which all have a family likeness, and which, in fact, among naturalists, form the quite homogeneous family *Culicidæ* in the order Diptera. They are delicate insects of small size, the larvæ and pupæ of which live in stagnant water, and many species of which in the adult state make themselves dreaded by their sanguinary habits. All are provided with a rigid, horny beak as long as, or longer than, half the body. The majority are nocturnal and keep themselves concealed during the daytime in any place of shelter that they can find—ravines, ditches, grottoes, hedges, foliage, barns, cowhouses, stables, cellars, apartments, tapestry and furniture. The holds of ships are well adapted for their multiplication. Their beak consists of a stout bristle-like labrum with bristle-like maxillæ, together with mandibles thicker than the latter and barbed at the tip, and a single hair-like lingua, or tongue. Their six bristle-like organs are folded together within the hollowed labium, which is slightly enlarged at the tip and forms a gutter-like case for the rest of the mouth-parts. The slenderness of this instrument permits the mosquito to pierce the skin and integuments of living beings without resistance, and to suck the blood and lymph of animals and the juices of plants. Why should this beak at the same time inject into the wound a minute quantity of an extremely acrid saliva, and, with it, the arrangement without *raison d'etre* and without utility to the insect, and, in a measure, an aberration of a natural law. Animals, in fact, that attack living prey often inject into the wound a poison capable of benumbing their victim or of killing it; but, in the present case, the injection of the venom is purely malevolent and profitless. The number of species of Culicidæ known is about two hundred and fifty. Naturalists divide these into twelve genera, two of which are particularly interesting from our point of view. These are the common gnat or Culices and the Anopheles. The public confounds these, but naturalists distinguish them. All the species of Anopheles are not of equal importance for our purpose, since there are but seven in which the hæmatozoa of paludal fever has been found, at least up to the present.

The Calices are much more numerous, 172 species being known. The most common is the ordinary *Culex pipiens*. The majority, at least in our climate, are considered as harmless. Up to the present, at least, they have not been credited with the propagation of any disease. Such is not the case, however, in warm countries. There is one gnat, *C. ciliaris*, that disseminates the serious affection now known by the name of filariosis, and which is nothing else than the hæmaturic or hæmato-chyturic fever of the Asiatics and Australians and the elephantiasis of the Arabs. There is another gnat, *C. fasciatus*, to which, since the recent experiments of Messrs. Reed, Jas. Carroll and Agramonte, has been attributed the transmission of the yellow fever or "black vomit" that ravages the littoral parts of Africa and America. Finally, a Culex of undetermined species is suspected of being the disseminating agent of lepra. As for the geographical extension of mosquitoes, that is very wide. They are found in the five parts of the world. Although Europe harbors but three genera (*Culex*, *Anophelis* and *Aedes*) the species of these are, as an offset, quite numerous, twenty-five of *Culex*, four of *Anophelis* and two of *Aedes* being enumerated. The situation is nearly the same as regards Asia and Africa; but America and Oceanica are more prolific. It is well to remark that although mosquitoes develop in incredible abundance in warm climates, they are not entirely wanting in the cold zones. They are met with as far north as the polar circle. There are cold regions that are rendered almost untenable by the multiplication of these diptera, say Newfoundland, for example. In this case, however, it is not with true Culicidæ that we have to do, but rather with a related family, that of the Simulidæ.

If we consider the general trend of the ideas acquired, and, on the other hand, the short time that has elapsed since attention was called to this mode of propagation of diseases, we shall be led to think that the list of the affections due to the intervention of mosquitoes will not remain limited to the three or four that we have just enumerated. The first in which a proof of the rôle of mosquitoes has been obtained is filariosis. It was a long time ago that Patrick Monson, the eminent parasitologist, showed that the filaria of the blood had as its host, for a part of its evolutionary cycle, a species of gnat known as *Culex ciliaris*. There was but one step to take in order to apply this idea to paludism. After Laveran had made the parasite of this affection known, it occurred to Monson that the gaps existing in the evolutionary cycle of this hæmatozon might be filled by the mosquito, as had happened with the gaps in the cycle of the filaria. His pupils (R. Ross especially) verified this view. Finally, as regards yellow fever, the investigations of Ross, Grassi and Monson upon the two preceding affections paved the way for American physicians. The plan of the experiments was fully indicated. Messrs. Ames, Cook, Rees, and the Cuban Commission had the cleverness to carry them out in an irreproachable manner. Their experiments seem to be entirely demonstrated.

II.

It was about twenty years ago that Monson showed the intervention of the domestic gnat of Australia (*C. ciliaris*) in the propagation of filariosis. This is a serious affection of warm countries, the manifestations of which are varied, but exhibit the common character of being brought about by the entrance of a nematode worm, the filaria, into the organism. The filaria of the blood of man, or Bancroft's filaria, is more or less common in the marshy countries of Egypt, Barbadoes, Brazil, India, and Australia. It was discovered at Brisbane, in the latter country, in 1876, by Dr. J. Bancroft on opening a lymphatic abscess in the arm of a patient. Its aspect is that of a small worm two or two and a half inches in length and as fine as a hair. The male and female live side by side. The latter produces a certain number of eggs which develop within its body into filoform embryos and are expelled in a living state. It is therefore viviparous. The adult worms live in the lymphatic vessels. They interfere more or less with the flow of the lymph, and, above the point where they exist, cause an expansion of the cutaneous lymphatic apparatus and an infiltration of the conjunctival tissue. From this results a thickening and tumefaction that distort the limb and give it a massive aspect vaguely resembling that of an elephant. This is the elephantiasis of the Arabs. These tumors, inhabited at the beginning by a filaria, may form at other points and sometimes assume a truly monstrous development. According to Mr. R. Blanchard, from whom we borrow much of our information, individuals may be seen in China in whom the elephantiasic mass placed between the legs reaches such dimensions that it is impossible for them to move about without the use of a small wheelbarrow for supporting their huge tumor. In 1899, Dr. Kiepper operated at the Saint Louis Hospital in Senegal upon a negro who had a tumor of this kind weighing 92.5 pounds. Having reached the end of its growth, the female filaria, which inhabits some lymphatic vessel, gives birth to the living embryos that have enlarged in its ovary. The delivery takes place in successive emissions with remarkable regularity. The length of the little worms does not exceed from .08 to .01 of an inch. Their ulterior fate merits attention. They become distributed through the lymph, and then, with the latter, enter the blood. In this nourishing liquid they cause various alterations, and engender diverse morbid disorders, and, among these, a sort of hæmaturic fever. But, in the end, they are unable to subsist long in the blood, and therefore become destroyed therein and disappear in a few hours after adding a few disorders to those that the adult filaria has produced. The complete list of the symptoms of filariosis thus comprises varices, elephantiasis, hæmaturia, and chyluria.

For a long time, and up to the period of Monson's investigations, nothing else was known about the filaria. It was not known how it began, and, on the other hand, it was thought that it perished, as we have just stated, in the blood of man. But this apparent end is only an illusion. The embryos do not end their life in the blood vessels of man unless no avenue of escape presents itself. Now, as a matter of fact, there is a way in which they may leave the blood, and one that had not been thought of. The patient attacked with filariosis may happen to be bitten by a mosquito, which will absorb a certain quantity of blood, and, consequently, a certain number of embryos.

How did this possible intervention of mosquitoes present itself to Mr. Monson's mind? The story of this is interesting. The English observer had been astonished to see the passage of the embryos into the blood, that is to say, the emission of young by the female filaria, occur in successive discharges with very regular periodicity. It is no less astonishing that such periodicity is precisely that of the day and night that succeed one another. During the day the parasite is never found in the blood, but makes its appearance only during man's period of rest and sleep, or, in other words, during the night. Now, mosquitoes, in their habits, exhibit the same periodicity. They also, invisible during the day, are active during the night. They bite man and suck his blood just at the time that the latter is carrying the nocturnal embryos (*Filaria nocturna*). Things therefore seem to be regulated in the most appropriate manner for permitting of the absorption of these little worms, which, without this, would be destined to destruction. We have here a very remarkable adaptation of the nocturnal emission of filarian worms to the habits of the mosquito. It is such a coincidence that gave Mr. Monson the idea of endeavoring to ascertain whether, in fact, the mosquito absorbed these little nocturnal filaria and played a part in their evolution. Experiment gave a positive answer. In the stomach of the mosquito that, at nightfall or during the night, has bitten a person attacked with filariosis, we find a few embryos of the filaria which at that time were circulating in the blood. Twelve hours afterward they traverse the wall of the mosquito's stomach and lodge in the muscles of the thorax, where they become transformed into larvæ. It is here that we lose sight of them. Knowing no longer what becomes of the larva up to the moment at which we find it again in man's lymphatic vessels, it became necessary to fill this hiatus in the observation. It was supposed that after the death of the mosquito, the existence of which is limited to about fifty days, its remains became destroyed in the water, and that the young filariæ, being set at liberty, then led therein a free and active life. It often happens, in fact, that after ovipositing, or after laying its eggs on the surface of the water, the female mosquito drowns herself. The movable, swimming, as well as liberated larvæ of the filaria might be swallowed by man, who would then absorb the germ of the disease. According to this, the transmission to man would take place through contaminated water, and the use of filtered or boiled water ought to ward off filariosis.

Mr. Monson had long before found that the filaria, in the course of its existence, had two successive habitats—man and the mosquito; but not knowing as yet how the evolutionary cycle was completed, and how the parasite managed to return to man, the English scientist adopted the idea of this third habitat, viz., water, through which the remains of mosquitoes were disseminated. This is what has been believed up to very recent years, but erroneously; and the history is at once more complicated and simple. In 1897 Mr. Monson resumed the study of the evolution of Bancroft's filaria, with the collaboration of Bancroft himself and Dr. G. Low. These three observers followed the evolution of the embryos of the filaria through the mosquito's stomach and in the muscles of the thorax, where they grew and became transformed into larvæ. They thereupon found an unlooked for fact, and that is that these larvæ do not remain inclosed in the muscular mass, as if in a prison without egress, but, after abiding and growing therein for about seventeen days, leave their shelter and begin their journey. They have now reached a length of about .02 of an inch and have sensibly the form of the adult. They make their way toward their host's mouth and finally enter its beak, and the latter, so to speak, becomes plugged up. It is now clear that if the mosquito (*Culex ciliaris*) happens to bite a person in the leg or arm it will introduce some of these young filaria into the wound along with its saliva. These filaria will enter the lymphatic vessels and reproduce the development, of which we have just reviewed the different stages. The evolutionary cycle is, so to speak, thus closed upon itself. The filaria goes from man to the mosquito, and returns from the latter to man. At no moment is it free from its environment. It has not three successive habitats, but two only. It is wrong, then, to suspect water of transmitting the disease, and there will be no use of filtering or boiling it.

It will be remarked that this evolution of the filaria, passing from man to the mosquito and from the mosquito to man, is precisely that of the hæmatozoa of paludism. One is a facsimile of the other. In fact, it was the history of the filaria that threw light upon the parasite of Laveran.

III.

Yellow fever, tropical fever, "yellow jack," or "black vomit," is the most serious of the diseases that prevail in tropical countries. Its ravages extend, in an endemic state, over a large portion of the coasts of America and East Africa. Its rages over littoral countries and lowlands, and at the mouth of and along the banks of large rivers, that is to say, in regions abounding in mosquitoes. There is no doubt that it is a contagious disease; but the cause of it is not well understood. This is not the place to discuss the opinions that have been advanced on the subject of its parasitic nature, and, particularly, to decide whether Sanarelli's bacillus characterizes the disease itself or some one of its possible complications. Since we are certain of the epidemic and contagious character of the disease, our ignorance as to the exact nature of its parasite does not prevent us from endeavoring to ascertain what may be the methods and processes through which it is transmitted. The question at present seems to be pretty nearly solved, owing to the experiments made last year by the American Commission in Cuba. It seems to be established that here again it is the mosquito that propagates the disease to the healthy subject and thus serves as a go-between to the contagion.

In order to understand the economy of these experiments, it is unnecessary to have much of a knowledge of the disease. It suffices to know that its progress is always rapid and sometimes terrible. We can give some idea of it by stating that in most cases it begins abruptly, with a violent headache, extreme lassitude, chills and fever. Then supervene nausea and vomiting, accompanied with a painful sensation in the epigastrium. This first period lasts three or four days, after which the digestive symptoms become pronounced, the vomiting becomes hæmorrhagic and black, and during this time the visceral disorders manifest themselves and the involvement of the liver and spleen is indicated by a more or less decided icterus (jaundice). Between the fourth and eighth day the patient either succumbs or becomes convalescent. In most cases the result is fatal. It should be said, further, that there exists a natural immunity against yellow fever, and an immunity acquired by a previous attack of the disease. Finally, it has been found that the infectious agent exists in the blood. In fact, the blood of a patient injected under the skin of a person in health quickly conveys the disease to the latter. These very simple ideas were certainly familiar to all those who, during the month of October, 1900, attended the sessions of the Congress held at Indianapolis by the members of the American Public Health Association, and who heard the exposé of the researches of Messrs. Reed, Jas. Carroll and Agramonte upon the propagation of yellow fever. These experimenters had endeavored to obtain cultures with the blood of some thirty subjects attacked with "black vomit," and had satisfied themselves that the Sanarelli bacillus exists therein only occasionally. They finally made a more hazardous experiment in trying to contaminate eleven persons by exposing them to the bites of mosquitoes (*Culex fasciatus*) that had previously bitten patients attacked with yellow fever. Two of these subjects caught the disease. The experiment was therefore partially successful, but the proportion of the failures encountered was as yet too great to permit of a positive conclusion. It became necessary to know the reason of such failures, and so a new campaign was required. This was immediately undertaken. In the month of November, 1900, a sort of sanitary camp was established in the vicinity of Quenado, Cuba, upon uncultivated, salubrious, well drained and well exposed ground. The personnel of the commission comprised thirteen persons (only four of whom were immunized), in addition to two physicians, Drs. Ames and Cook. There were, moreover, some young, vigorous and healthy individuals in the

* In Revue des Deux Mondes, Translated for SCIENTIFIC AMERICAN SUPPLEMENT.

camp who had just undergone a quarantine of observation and who were consequently immune from any external contamination. The field was protected by a sanitary cordon. The physicians had at their disposal a collection of mosquitoes living in tubes and that had, at more or less recent epochs, bitten persons attacked with yellow fever. They had also boxes of contaminated linen that had been sent from the Las Animas and Columbia barracks hospitals, and that were to be opened only at the moment necessary. Men with willing hearts were at hand to submit themselves to the experiments; but let us say at once that none of these became a victim to his devotion.

The result of these researches may be given in a few words. Nearly all the subjects who were bitten by the contaminated mosquitoes contracted the disease. Inversely, all those who, duly preserved from the bite of the mosquitoes, exposed themselves to the common causes up to then invoked, such as lying upon bedding soiled by the dejectal of patients in an imperfectly ventilated room, at a moist heat of 33 degrees, remained proof against the disease. Such a regimen, continued for three weeks in succession, with a daily renewal of the soiled bedding, remained without effect. The three persons who had submitted themselves to it came from the test in perfect health.

The Cuban Commission even devised a sort of comparative experiment which might be qualified as crucial. The interior of a barracks was divided into two exactly identical compartments by means of wire gauze hung from the ceiling to the floor. In one of these compartments fifteen contaminated mosq toes were set free, and a young American named Moran entered and exposed himself to their bites. Two non-immunized men took up their quarters in the other compartment and remained therein permanently. Moran was attacked with the yellow fever, while his two companions remained in perfect health. The contamination by mosquitoes solely was evident.

How long does it take for the bite of a contaminated mosquito to become effective? The preceding experiments have shown that a mosquito that has just bitten a yellow fever patient cannot transmit the disease immediately, and that it is not till twelve days later on that it can do so. It requires from twelve to eighteen days for the insect to become contaminative, and previous to such lapse of time its bite remains harmless. Moreover, a bite received during this period does not confer immunity, and does not produce an attenuated form of the disease. This fact seems to indicate that the mosquito is not a pure and simple transporting agent. The infectious parasite of yellow fever doubtless undergoes in the tissues of the insect an evolution that requires a dozen days; after which, returning to the organism of man, it is capable of developing the disease therein.

These experiments have, in addition, made known the true duration of incubation of the yellow fever germ. The disease breaks out and the preliminary symptoms exhibit themselves within a period varying from two to five days after a person has been bitten by the infected mosquito.

Upon the whole, the mosquito (*Culex fasciatus*) is the propagating agent of the specific parasite, as yet unknown, of the yellow fever. It obtains the parasite from the victim of yellow fever, and it is not till twelve days later that it is possible for it, upon biting a healthy and non-immunized subject, to transmit the parasite and communicate the disease to him. The disease makes its appearance six days afterward. As for dust, soiled linen and bedding, objects that have been been used by the sick, and merchandise coming from localities in which the epidemic prevails, contact with them is attended with no danger; and to disinfect them is useless unless it is desired to destroy mosquitoes that have been preserved alive among them. An efficient disinfection consists in the destruction of the insects.

From the viewpoint of the prophylaxis of the yellow fever, nothing is more judicious than the prescriptions offered to the American army in Cuba by Major General Wood in a circular of April 27, 1902, and which the following is the substance: "Since malaria, yellow fever and filariosis are transmitted by mosquito bites, the General prescribes the use of mosquito-bars in all barracks and hospitals. He recommends the destruction of the larvæ by means of petroleum poured upon the surface of reservoirs and cisterns. This will not unfit the water for drinking or washing purposes, provided it be drawn off from below. If a room or building is infested with mosquitoes that have sucked the blood of a person attacked with yellow fever, it should be disinfected by destroying the insects through fumigations of formic aldehyde, sulphur or insect powder. Patients should be isolated as soon as the disease is recognized and kept from contact with mosquitoes. It is the patients who are not sick enough to go to bed that are the principal cause of the spread of the disease. As mosquitoes are not migratory and never go very far from the spot where they were produced, the prolonged presence of malaria at any post would indicate a want of care and diligence on the part of the surgeon and commandant.

IV.

This absolute and rigid doctrine of the propagation of these diseases by mosquitoes does not possess the character of a demonstrated truth in all its parts. As a whole, the doctrine, without doubt, presents an unquestionable experimental stability; but in a few points it lacks strength. For example, we may find the affirmation that the evolution of specific parasites consists, always and everywhere, in a periodical to-and-fro movement between man and the mosquito and the mosquito and man, too rigorous. As regards malaria or paludism, certain observations do not accord well with this dogmatic assertion. How does it happen that, in new, desert or sparsely inhabited countries, explorers can contract fevers? That legions of gnats and even of Anopheles exist we readily admit. But whence did the latter get the infection and how did they preserve it, since the advent of man there is so rare? If we admit the fact, and it seems to be unquestionable, that the few travelers who traverse these new countries contract fevers therein, we shall be obliged to admit also that the innumerable generations of mosquitoes that succeed each other may communicate to each other the germ of the disease, the Laveran hæmatozoa. This latter, which is unable to accomplish its entire evolution in man, must be able to do so in the mosquito. Hence it is the mosquito that is the normal host of the parasite, and man, on the contrary, is merely the accidental or occasional host. But he might not intervene, and how would things proceed then?

An evolutionary cycle of the hæmatozoa of malaria from which man is excluded may be conceived of in different ways. The infected female might transmit the germ of the hæmatozoa to the egg and, thereby to a new generation. This is what happens with a silkworm attacked with pebrine, an affection due to a sporozoa. The same thing is true again with the tick that communicates fever to Texas steers. The female tick becomes infected upon the diseased animal and, through its eggs, transmits the infecting germ to its progeniture. Things might proceed in this way with the mosquito relatively to the hæmatozoa of malaria.

The male mosquito has an incomplete buccal apparatus, which is ill adapted for piercing the integuments of mammals. It does not bite man. The female is better armed, and it is she exclusively that torments us and becomes the agent of morbid contaminations. At the inception of all disorders due to mosquitoes, the female must be sought. The blood of animals is for her a necessary, or, at least, a very useful aliment for bringing her eggs to maturity. As for the male, he lives innocently upon the juice of plants and the nectar of flowers. The female herself is content with such a regimen when no other is furnished her; and it is thus that naturalists preserve in captivity the mosquitoes designed for their experiments, that is to say, they place at their disposal bananas or other fruits.

Up to the present, there has been nothing to prove that the parasite of paludism or malaria really passes through the egg of the mosquito from one generation to another. Such a process, were it that of nature, would nevertheless very perfectly realize her views. The perpetuity of the species would be assured without useless waste, since the females, which alone suck man's blood, and which are, to the exclusion of the males, the hosts of the hæmatozoa, would be capable, to their exclusion also, of transmitting the germs thereof to the following generations. But if the transmission were not effected by the eggs, it might be through the alimentation. The parasitic hæmatozoa of the female would, under the form of ookystes or sporozoites, be set at liberty when its body was destroyed, and be swallowed with the debris of the body by the young larvæ. This is possible, and was what was thought to be the case with the mosquitoes of filariosis; but, as we have seen, experiment has contradicted such a supposition. In default of such direct mechanisms, some other and indirect one in which the external medium, that is to say, the earth or water, plays the intermediate rôle and harbors the hæmatozoa between one generation of mosquitoes and another, must be imagined.

These discussions have not solely an academic character. They involve consequences that are important for practice. The prophylaxis of malaria and the hopes to which it gave rise will be profoundly modified, according to which of the alternatives is true.

In fact, according to the rigorous doctrine of the alternate to-and-fro movement of the hæmatozoa between the mosquito and man, it will be seen that the cure of the latter involves that of the mosquito and *vice versa*. So the tactics of hygienists should tend toward attaining one of these three objects, viz., the driving away of the mosquito, the killing of it, or the curing of it. In order to prevent the mosquito from reaching man, recourse is had to mosquito-bars, and window and door frames provided with wire gauze. In the second place, an effort may be made to destroy the insect by draining the land adjacent to the habitation by getting rid of all collections of stagnant water, or by pouring petroleum upon it. Finally, we may try to preserve the mosquito by isolating the patient and preventing the insect from becoming infected through him. Of these three means, it is permissible to judge that, at present, it is the latter that seems most efficacious. Grassi, the Italian physician and naturalist, who has recently undertaken to rid the Campagna Romana of malaria, and to restore to Ostia its ancient salubrity, seems to have succeeded therein by treating all the feverish persons who frequent these plains at the harvest season with "esanophele," a wonderful mixture of quinine and arsenic. It is evident that if the doctrine is not exact, if the transmission is done by the soil, this great hope of regenerating unhealthful Italy would be but an uncertain dream.

## "CRIME" AMONG ANIMALS.

Facts show beyond question that in the animal kingdom there are many curious equivalents of crime among men. Cannibalism is not unknown in the animal world. Wolf eats wolf, and in certain circumstances, and despite proverbs to the contrary, dog will eat dog. Well-nourished dogs are not often guilty of this savage custom, though it has been observed where necessity did not impel; but Arctic travelers have frequently fed their famished Esquimo team on the carcasses of brethren that died from effects of cold or hunger, and under such conditions mothers have devoured their puppies with no hesitation or lack of appetite. Domestic cats have killed and eaten their young, and rabbits have been known to feed on one another even when plentifully supplied with food to their liking. The rat is nearly always a cannibal under stress of circumstances. The cannibalistic propensities of the pike need very little stimulus. Young crocodiles are occasionally gobbled by their parents or at least by their mothers. Warrior ants devour in a fury the ants they have killed in battle.

A certain famous case in the reptile house at the Zoological Gardens was evidently not one of genuine cannibalism, but serpents have been guilty of the act. Infanticide, patricide, matricide and fratricide are aggravating circumstances of cannibalism in the animal world. There are crimes known to our calendar of which the only or the chief motive appears to be the inveterate dislike of one individual (the assailant) for another (the assaulted), and these strange antipathies exist in the animal world, and are the cause of assault and battery, and often of the death of both parties. Horses, dogs and monkeys furnish many examples of violence proceeding from antipathy. The sudden gusts of uncontrollable rage which impel the Malay to run amuck through his native High Street, seize at times upon the gentlest of animals, and the results, are much the same as in the Malay Peninsula, unless the subject of his brief terrible madness can be caught or slain. Different are the cases of animals proverbial for their patience, which may be goaded into a fury.

The dromedary, ordinarily a model of good behavior, is sometimes teased by his drivers until they are compelled to fly before his rage or to strip off and throw him their garments that he may tear and trample them to pieces. Everyone knows to what a pass the docile elephant will carry his desire for revenge, when his dignity has been badly insulted or his good nature abused. More curious it is to note that, among animals as among men, some of the worst offenses that can be committed have their origin in the passion of love. Jealousy burns fiercely in many a brute's bosom, and when affected with the "universal distemper of love" the whole animal creation, from the tiger to the dove, is capable of any excesses against its disturbers, whether of its own or the human kind. Association for deliberate purposes of wrong-doing is not rare among animals, both of the higher and the lesser order of intelligence. Other animals steal in bands. Baboons go out in troops to rob orchards difficult of access. Conditions of climate and change of atmosphere have their influence upon the temperaments of animals. Speaking generally, wild creatures inhabiting very hot countries are more savage than those inhabiting cold or temperate climes.—London Leisure Hour.

## WHY ARE SEA BIRDS WHITE?

There are five possible explanations of that whiteness which is so characteristic of sea birds—namely, first, that it is given them as a protection from their enemies; secondly, that it is due to that absence of elimination to which land birds dressed in an eccentric garb are subjected; thirdly, that it enables them more easily to procure their food; fourthly, that it is due to sexual selection; and, lastly, that it forms, in combination with dark wings or tail markings, a badge by which they may be recognized by their friends. The first explanation, which finds most favor with naturalists, the writer ventures to dispute altogether. Color may be either a screen, behind which its owner can safely live and freely move, or a signal of danger, like the warning red flag above a powder magazine. The tawny hue of the lion and of the gazelle, which assimilates them to their surroundings, and aids the pursuer and the pursued in turn, is an example of the first. As an example of the second we have the gaudy colors of many butterflies, and the black, white, and yellow of the magpie moth, which advertise the paradoxical fact that the insects are unfit for consumption. Sea birds live under totally different conditions. They have no snow as a background; they do not swim in milk, or fly in an atmosphere resembling that of a flour mill, and the supposed analogy between their circumstances and those of Arctic birds is a poetic figment. The normal hues of the ocean are blue, green, and gray. White upon blue is one of the most striking contrasts possible, and white upon green is little less distinctive. If gray in itself does not excite attention, white on a background of gray is thrown into instant relief. Upon the supposition that whiteness confers invisibility on sea birds, we are driven to the strange conclusion that the young, which are often gray or brown, are left without protection, although they need it most. Before coming to the conclusion that whiteness makes sea birds invisible to super-aquatic eyes it surely is desirable to face the question, Is protection needed? Protection against what? We can quite understand why white land birds are so rare. A white vegetable-feeder would not long escape the talons and beaks of birds of prey, and birds of prey which called attention to their presence by obtrusive raiment would soon find their larder bare. But what have sea birds to fear? They are clamorous, greedy, fierce, and pugnacious; capable of defending their own interests, and feeding almost entirely on fish.

It is a suggestive circumstance that the colors of sea birds correspond in one important respect with those of the fishes on which they feed. Almost invariably a fish is dark above and light beneath, this distribution of colors helping it to escape observation. Now, nearly all sea birds are black and white, or gray and white, the darker tints being found on the wings and back, and the white feathers on the breast and abdomen. It may be, and probably is, an advantage to aquatic birds to have their white feathers turned seaward, so that they may be less easily seen by the fishes they are in quest of, and the fact that the eagles which have taken to fishing are colored like their nautical colleagues lends weight to this consideration. The tendency to whiteness once encouraged, whether by absence of danger or as an aid to the procuring of food, might well be intensified by sexual selection. Lastly, there can be little doubt that a potent influence in the decoration of birds is the necessity for marks whereby members of a species may recognize each other. These "banner colors," as they have been called, are shown in the wings and tails of many sea birds, black bars crossing the outer feathers of the gray or white pinions and of the expanded fans.

Such are the considerations which lead to the conclusion that the usual explanation of the whiteness of sea birds—namely, that it is a device to make them invisible to aerial enemies—is entirely erroneous. Why, then, are sea birds white? The answer is, for four cumulative reasons. First, they are white because flesh-eating enemies powerful enough to weed out whiteness are absent from the element which they frequent; secondly, because whiteness, and especially a white under-surface, facilitates their approach to the fishes which form their food; thirdly, because the preference of the sexes for each other, taking the line of least resistance, has accentuated the tendency to whiteness; and, lastly, because a white plumage forms, in combina-

tion with black markings, an excellent signal by which friend can recognize friend, and the whereabouts of food be quickly indicated.—Longman's Magazine.

## THE HARPOON—FOREMOST AMONG SAVAGE INVENTIONS.*

By Otis Mason.

The harpoon is the most complicated of all the devices invented by uncivilized people. The methods of taking animals for the various activities of life may be divided into the following nine classes:

1. Gathering or arresting without any device whatever.
2. Gathering or arresting with grasping devices that supplement the hands and fingers.
3. Striking, stunning, and bruising with weapons that imitate the fist or the foot.
4. Slashing with edged weapons.
5. Piercing or stabbing with pointed weapons.
6. Taking in traps or blinds, the hunter being out of sight.
7. Hunting down by means of other animals.
8. Capturing with smoke, fire, and light.
9. Overcoming by asphyxiation, poisons, or drugs.

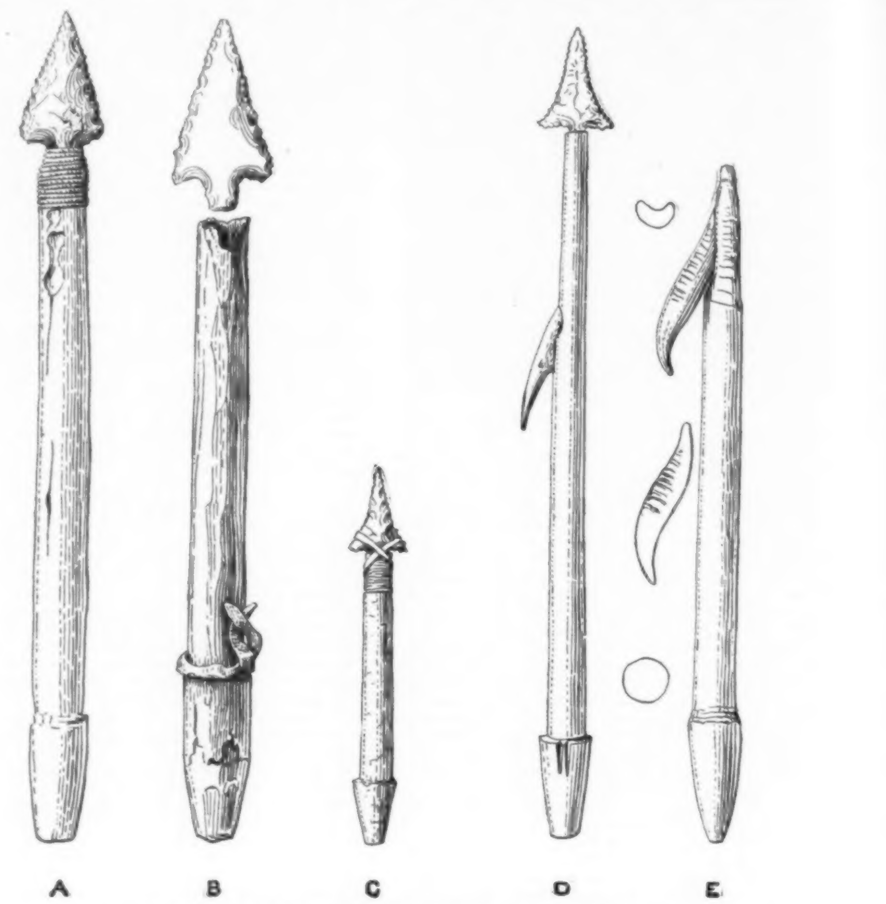
The harpoon belongs to the fifth, or piercing class, which may be divided into three subclasses: Those with a smooth blade, such as lances for stabbing and withdrawing; those whose blades or working parts have barbs on the sides, such as spears for retrieving as well as piercing; and the harpoon subclass, which is a spear with a movable or hinged head. A harpoon, therefore, is a piercing and retrieving weapon with a movable head.

Before taking up this weapon specifically it may be useful here to mention that many classes of weapons are used: (1) With a short handle or hilt, (2) with a long handle or shaft for thrusting, (3) with a light handle for hurling, or (4) constructed like an arrow to be discharged from a bow or some other projectile weapon. A full definition of a harpoon, therefore, would be "a piercing and retrieving weapon with a movable head, attached to a shaft held in the hand, to a shaft hurled from the hand, or shot from a bow or an atlatl (throwing stick). The last named weapons are sometimes called harpoon darts and harpoon arrows.

Now let us pay especial attention to the harpoon itself. For understanding the very earliest and simplest form an illustration will do much better than a great deal of text, so it will give us pleasure to journey with Magellan through the wonderful straits named after him, at the very southern extremity of South America, since our new possessions in the Philippine Islands are intimately acquainted therewith (Fig. 1).

On the left-hand side of the drawing is a Fuegian spear, with shaft, barbed head, and rawhide lashing. It is a spear, because it both pierces the fish and enables the man to retrieve his game. No little invention has been expended on this simple device; the shaft is split at the end, the head of bone has a shank fitted with notches so as to make the lashing most effective, and the barbs are cut on the soft side of the bone so as to leave the hard portion for strength.

On the right-hand side of the picture and in the



BARBED HARPOON HEADS, CHILE AND PERU.
Fig. 2.—A-C. Cat. Nos. 136,850*a* and *b*, U. S. N. M.; D, Peabody Museum; E, Charles Read.

* Abstract from a Bulletin Published by the Smithsonian Institution.

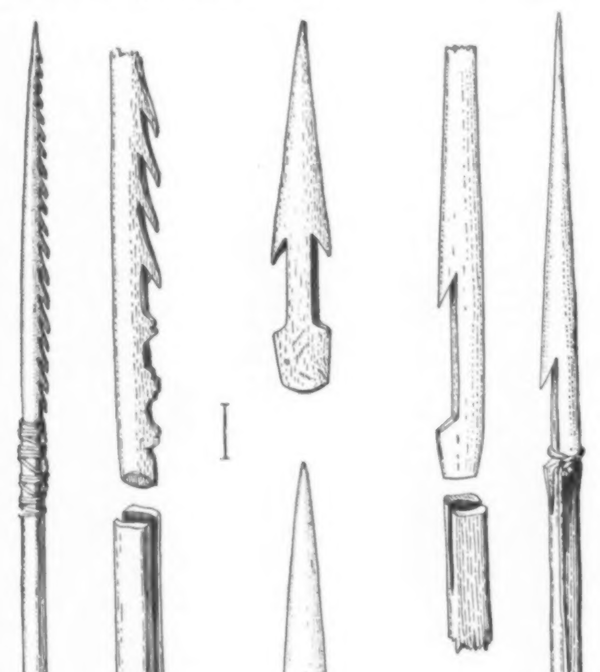


Fig. 1.—FUEGIAN BARBED HARPOON HEADS.
Collected by U. S. Fish Commission Steamer "Albatross."
Cat. Nos. 127,556, 131,217-8, 178,805, U. S. N. M.

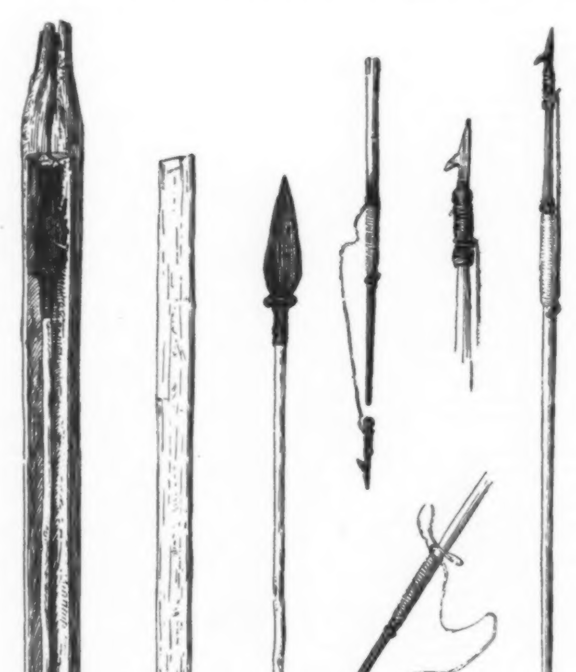


Fig. 3.—HARPOON ARROW AND SHEATH, VENEZUELA.
Museum of the University of Pennsylvania.

middle, the spear has turned into a harpoon. One may see that much thought has been expended on the form of the head—in some cases with one barb, in others with two. The tang, or lower end of the head, is wedge-shaped and somewhat thickened in the middle. The end of the shaft is partly bored and partly saw-cut. The tang of the head is set into this neat socket, a short rawhide line is tied around the tang and the other end of the line is neatly attached to the shaft, a few inches away. The problem is solved. The fisherman plunges the head into a large sea animal, weighing, perhaps, two hundred pounds. The victim gives the death struggle, which would snap a spear shaft in two instantly, but the accommodating tang slips from the socket and the long shaft immediately lies crosswise in the water and furnishes the best possible drag. Not only this, but being of small specific gravity, when the victim attempts to dive it at once operates as a buoy. This apparatus passes, as we shall see, through many transformations and has a multitude of additions and accessories, but all of the important elements are represented in this invention by the lowest savages on the face of the earth.

The simple Fuegian barbed harpoon represents, in its essential features, some very ancient types, shown in Fig. 2, from the graves of ancient Chile and Peru. Not having such excellent bone to work upon in those being too weak. Into the reed at the fore end is a short bit of hard black palm wood, which may be called the foreshaft, firmly inserted and held in place by lashing. Upon the outer end of this the socketed portion of the harpoon head is loosely fastened. The assembling line is attached to the shaft and to the shank of the head; it is much longer than the Fuegian line, and is rolled up securely on the shaft and fastened off with an easily unshipped bow knot. When ready for action the head is set in place, the line is drawn tight in the bow knot so as to keep the parts together, the weapon is rammed into the game, the harpoon-head is pulled from the shaft, the bow knot is easily unloosed, and the line run out to its full length. Let us think for a moment what advantages have been gained here. As in the Fuegian example, the shaft acts as a drag and buoy, but with a long line the hunter more easily approaches the wounded and may even from his boat retrieve the shaft and haul the victim, dead or alive, within reach.

An immense advantage over the Fuegian type is secured by having the foreshaft of heavy, hard wood, while the shaft is of the lightest possible reed, so that when the line is unshipped the shaft, instead of lying on the water horizontally, takes a vertical position. The heavy palm wood foreshaft drops lower, while the upper light shaft with its feather goes bob- one attached to a long shaft, the other as a harpoon arrow. You will find these in use along the Aleutian Peninsula and down the coast, especially wherever the sea-otter is hunted.

Fig. 4 represents the finesse of a barbed harpoon and is from Kadiak, Alaska. Beginning at the right hand, notice that you have a repetition of the Fuegian ideas in more refined forms: The barbed head with ratcheting notches on each side, the socket in the fore end of the shaft wrapped with the daintiest sinew braid, a thong of rawhide through the shank of the barb, attached by a Turk's-head knot to the long line of braided sinew. Besides the dainty ornamentation on these parts, the figures in the middle of the plate will show the hand rest projecting from the shaft in order to give the hunter a firmer hold when he strikes, and the bladder of seal attached by a beautifully ornamented shoulder to a lower portion of the shaft. When the harpoon is in action this bladder will be inflated. In the figure at the extreme left the harpoon is mounted for work. The head is in its socket, the braided line is unrolled to show how at its outer extremity it is bifurcated like a martingale—one end tied around the shaft near the head, the other at the bladder. When the game is struck the animal pulls the barbed head away from its socket, the line unrolls, the bladder holds the outer end of the shaft vertical,

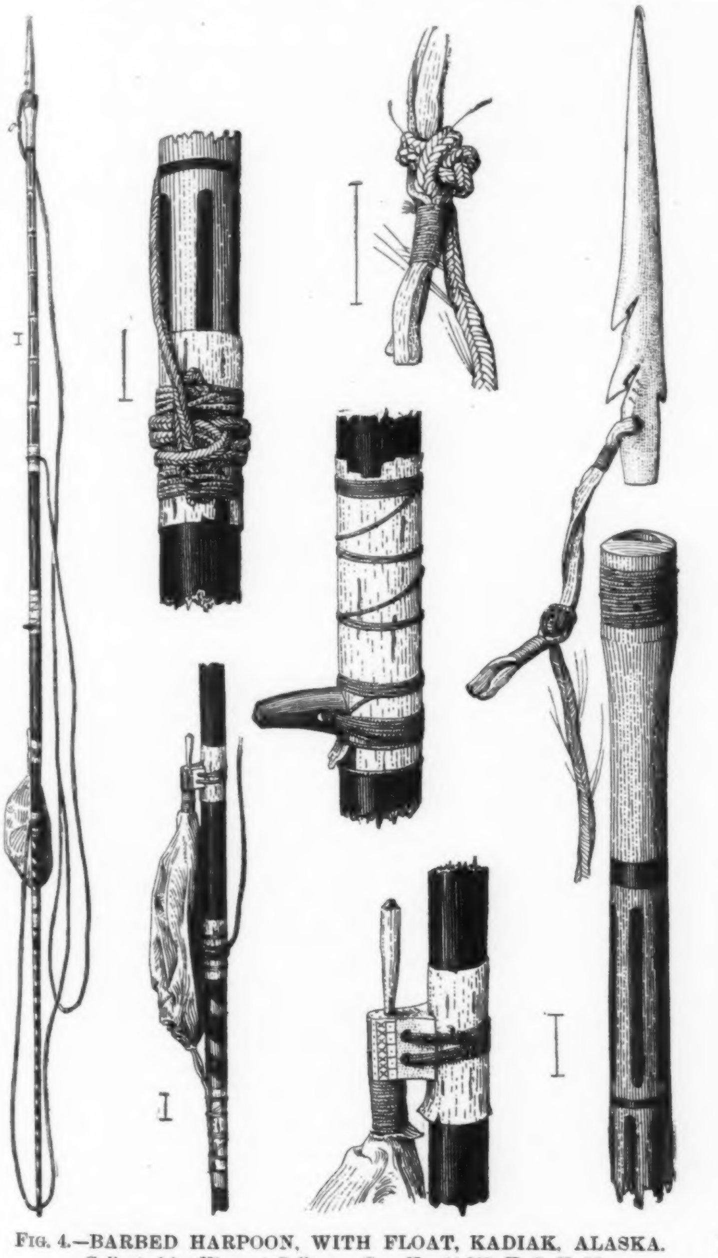


FIG. 4.—BARBED HARPOON, WITH FLOAT, KADIAK, ALASKA. Collected by Vincent Collyer. Cat. No. 11,362, U. S. N. M.

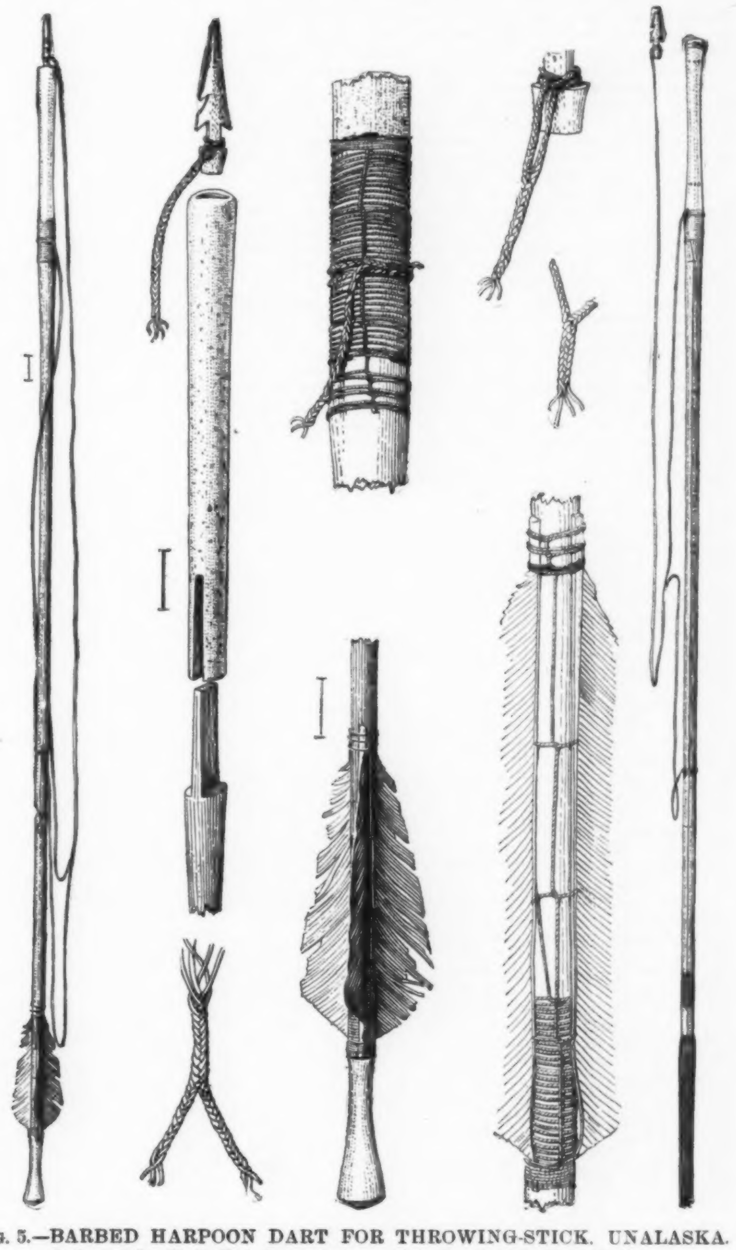


FIG. 5.—BARBED HARPOON DART FOR THROWING-STICK, UNALASKA. Collected by U. S. Fish Commission. Cat. No. 175,825, U. S. N. M.

arid countries, ingenious minds were driven to extremities and the simple bone head became the pointed head with blade of stone and shaft of wood, bound together with twine or thread. The tang at the end has a notch cut so as to hold the rawhide thong or assembling cord. In addition, barbs were inserted on the side of the shaft, made of bone or shell, and fastened with pitch.

Any inventor will notice, however, that the insertion of the wedge-shape tang of the harpoon head into the slit or cavity at the end of the shaft is weak, and this brings us to tribes of Indians living in Venezuela on the drainage of the Orinoco River. It occurred to them to sharpen the end of the shaft and attach the socket to the head of the harpoon, as shown in Fig. 3. Especial attention is called to this figure in its details because, though rude, it has in it very interesting features pointing forward to some of the most remarkable parts of the perfected instrument. On the right-hand side of the picture is a harpoon arrow-head. The shaft is of reed and very light; at the shaftment or outer extremity there are two half feathers set on to guide the flight. A piece of hard wood is set in the reed at this point to form a notch for the bow string, the original material of the shaft bing about over the water as much as to say to the hunter, "Here I am; look at me; come this way," like a hand beckoning. Further on it will be seen that the cunning Eskimo made the fore end of their shafts of heavier material.

On the Solimoens in Brazil, the Indians make a turtle harpoon arrow after the same fashion with a steel point for a blade which enters the shell of the animal. The shaft is set free and the animal dies, but its position is so well indicated by the buoy or arrow shaft that the hunter has no difficulty in shooting another arrow into the air, which coming down with tremendous force strikes deeply into the body of the submerged animal. The manatee, in the same area, is hunted in small canoes and killed with harpoons of precisely this variety.

All over the Middle States of the Union, the Mississippi Valley and wherever mounds existed, especially in the State of New York, immense numbers of bone harpoon heads have been recovered both from cemeteries and from the tumuli. You will see them figured in endless variety in Dr. Beauchamp's Bulletin 50, New York State Museum, Albany, 1902.

The perfection of the barbed harpoon is found on the northwest coast of America in two varieties, the and, as in the case of the Venezuela specimen, only in a more pronounced fashion, the outer portion of the pole acts as a buoy, informing and giving the hunter constant warning as to the position of the game. The perfect adaptation of parts in this harpoon and the artistic way in which the bone is carved, the wood is shaped and decorated, the points and different parts are padded with white birch rind constituting a most effectual protection, place the Kadiak harpoon at the head of its class.

Similar in structure and function to this Kadiak specimen is the delicate sea-cotter harpoon arrow used around the Alaskan peninsula. Especial attention, however, is called to the existence of a foreshaft of heavy bone or walrus ivory attached to a shaft of light cedar wood. The bone is firmly joined to the shaft and wrapped with braided sinew. At its outer end it is neatly socketed to fit the tenon on the end of the barbed head. The attachment of the braided line with its martingale and the loose bow knot holding all in place when the line is set are old acquaintances.

The most costly of all the fur-bearing animals is the sea-otter, and it is, therefore, appropriate that the most highly finished and elaborate arrow in the world

should have been made for its capture, but we must go one step further to reach the climax of the barbed harpoon (Fig. 5). There was, in ancient times, a projectile device, used in many parts of America, called the throwing stick (Atlatl, in Mexican). It is a most useful device for a man sitting in a canoe that is easily upset, since he may steady himself by means of his paddle held in the left hand, while with his right hand alone he may project his heavy weapon, much larger than any arrow.

In Fig. 5 is shown, both in its parts and assembled, the sea-otter dart. The barbed head, the socketed foreshaft with its joint on the shaft, the feathers for directing the flight of the arrow, and the peculiar end to fit the throwing stick are all well illustrated.

(To be continued.)

## ELECTROLYTIC PRODUCTION OF METALS, WITH SPECIAL REFERENCE TO COPPER AND NICKEL.*

By Wm. Koehler, Cleveland, Ohio.

In considering this subject, we enter a field made attractive by the successful experiments of painstaking, original investigators, but hedged about with patents obtained by persons who seek to appropriate the results of these experiments which they had neither the patience nor the wisdom to make. We shall find that electro-metallurgy is based on facts known to generations earlier than our own, and by their age the common property of every scientist of to-day, and that the principles involved are so much matters of general knowledge that they are not the special properties of any man or association, that all are free to use them, and that any process, by whatever name it is known, is protected by patents only to the extent in which it is a combination of these well known principles with some patentable invention.

Electro-metallurgy, or, in other words, the electro deposition of metals from solutions, as at present practised, is not to be confounded with the production of metals by means of heat generated, and the electrolytic action dependent upon the reduction, in an electric furnace. It is more than that, and is naturally divisible into two branches: First, the electrolytic refining of crude metals, and, second, the direct production of metals from solution.

Before entering directly upon the subject under discussion, it may be well to give a few moments to electrolysis in general. By electrolysis we mean those chemical reactions which take place when a suitable electric current passes through a chemical combination, which is technically termed an electrolyte. In producing electrolysis conductors of two grades or classes are necessary. Conductors of the first class are wires or sheets of conducting material, such as are used in the mechanical arts, their object being simply the conveying of the electric current from a point of higher to a point of lower potential difference. A conductor of the second class is always a chemical combination, existing either in solution or in a state of fusion. In electrolysis, conductors of the first class work in pairs. The electric current is not complete when a conductor of the first class enters a conductor of the second class, and to complete the circuit another conductor of the first class must also enter the conductor of the second class, usually at a point opposite that at which the first entered. This pair of conductors of the first class, when in contact with the electrolyte or conductor of the second class are known technically as electrodes, and it is virtually at these points of contact that electrolysis manifests itself. The electrodes are distinguished with relation to the direction of the electric current, as the anode and cathode respectively, the current entering the electrolyte at the anode and leaving it at the cathode. On account of the potential difference produced by the electric current at the electrodes, substantially different masses of the electrolyte (directly proportional to the quantity of current passing) are set in motion. These moving masses, composing the electrolyte, are termed ions, and, for further distinction, those moving toward the anode are called anions; those moving toward the cathode, cathions. At the electrodes proper, in an electrolyte, the ions undergo a chemical change, and this change is known as electrolysis.

The results of this change, according to conditions under which electrolysis takes place, can become of a very complex nature. Under primary conditions the results are comparatively simple. For example, the electrolysis of copper sulphate or sodic chloride solution produces in the first case copper, sulphuric anhydride and oxygen, while, in the second case, sodium (or sodium hydroxide and hydrogen) and chlorine gas are produced according to the following equation:

$$\begin{array}{lll} CuSO_4 \text{ gives} & Cu + SO_3 & \\ & SO_3 + H_2O = H_2SO_4 + O. & \\ NaCl \text{ gives} & Na + Cl & \\ & Na + H_2O = NaOH + H. & \end{array}$$

A given quantity of the electric current passing through different electrolytes will always set free the same number of valences or transfer them into different combinations. This can most readily be shown by allowing the same current to successively pass through different electrolytes. Results are shown in the accompanying table.

The figures, representing the quantities of cathions liberated, give when compared to one unit weight of hydrogen, the amount of metal represented by one of their valences, while a single valence represents its atomic weight. In the solutions 2 and 4, the silver and copper atoms are monivalent, in 3 and 5 the copper atoms are bivalent, while in 6 the tin atoms are quadrivalent.

From the foregoing it will also be seen that the quantity of cathions or anions liberated are proportional to the strength of the current and the time through which it is acting. According to researches of F. and W. Kohlrausch, 0.3281 mg. copper are liberated from the solution of an oxide salt of copper by one coulomb.

0.6578 mgs. of copper from cuprous salt.

* Paper read before the Canadian Mining Institute.

| | Electrolyte | Electrodes | Cathions liberated | Compared to 1 milligramme Hydrogen | Atomic Weight | Error |
|---|---|---|---|---|---|---|
| 1. | Dilute Sulphuric Acid 1 to 12 $H_2SO_4$ | + Platinum — Platinum | 6.002 mg. Hydrogen | 1 mg. Hydrogen | Hydrogen 1 | |
| 2. | Potassium Silver Cyanide KAg $Cu_2$ | + Silver — Platinum | 650 mg. Silver | $\frac{650}{6.002}$ = 108.2 mg. Silver | Silver 107.6 | + o, 6% |
| 3. | Cuprious Chloride $Cu_2Cl_2$ | + Copper — Platinum or Carbon | 380 mg. Copper | $\frac{380}{6.002}$ = 63.6 mg. Copper | Copper 63.3 | + o, 4% |
| 4. | Cupric Chloride $CuCl_2$ | + Copper — Platinum Carbon | Reduction of 190 mg. Copper | $\frac{190}{6.002}$ = 31.8 mg. Copper | Copper 63.3 | + o, 4% |
| 5. | Copper Sulphate $CuSO_4$ | + Copper — Platinum | 190 mg. Copper | $\frac{190}{6.002}$ = 31.8 mg. Copper. | Copper 63.3 | o, 4% |
| 6. | Stannic Chloride Sn. $Cl_4$ | + Platinum or Tin — Platinum or Carbon | 170 mg. Tin | $\frac{170}{6.002}$ = 28.3 mg. Tin | Tin 117.8 | — 4% |

0.3050 mgs. of nickel from nickel oxide solution.

0.2394 mgs. of sodium from salt solution.

0.3682 mgs. of chlorine from chloride solution.

This list can easily be extended and the values of all elements calculated. The results are known as the electro-chemical equivalents. A coulomb being an ampere second, and knowing the potential difference necessary to overcome polarization and bring about dissociation of an electrolyte, the power necessary to deposit a certain quantity of metal from an electrolyte can easily be calculated. For example, estimating a horse power at 730 watts, or volt amperes, and figuring the potential difference of an electrolyte at one volt, a horse power will contain 730 available amperes. From the above we have the deposition of 0.3289 mg. copper through one coulomb, which, in one hour would be (0.3289 mg. x 3,600 seconds) 1.18 grms. copper per hour. 1.18 x 730 equals 861 grms. per hour per horse power, or 20 kilos, about 44 pounds, per horse power day.

As the subject of this paper is electrolytic production of metals, the methods by which matte and crude metal are obtained can only be briefly discussed. For their production various metallurgical operations are resorted to. The ores are subjected to roasting and smelting operations, thereby increasing the metallic values of the products and eliminating some impurities. When the metal content is sufficiently high they are subjected to what is known as the Bartlett-Thompson separation smelting, by this means producing crude copper and nickel. The crude metals are then electrolytically deposited in general from sulphate or chloride solutions on pure metallic cathodes. (Process by Titus Ulke.)

In the production of copper and nickel we will first take up the subject of refining. For this purpose a high grade matte, or, better still, crude metal of about 95 per cent fineness is necessary. The possibility of refining copper by this means was made known by Cruikshanks' researches, dating back to 1800. Of greater importance to refining in general is the process patented by Elkington in February, 1870. This process is the basis of all refining processes in present use, and the inventor claims the recovery of copper, together with the separation of other metals associated therewith. To this end copper ores undergo smelting operations until crude metal is obtained, which is then cast into plates. With the aid of electric current, these are dissolved in a suitable electrolyte and the copper deposited upon other plates. The precious metals contained in the crude metal fall during electrolysis to the bottom of the electrolytic vats. The inventor prefers working ores which contain sufficient silver to effect the good qualities of a pure copper. The impure, or blister copper, is tapped from the melting furnace into cast iron molds, about 600 millimeters long, 200 millimeters wide and 25 millimeters thick. In one end of such a plate a large and heavy T-shaped headpiece of copper is cast into the same. The object of the T-shaped headpiece is to provide means for the suspension of the plate and at the same time secure electrical contact. These plates are then suspended, together with the cathode plate, in earthenware vessels arranged in terrace form. This terracing is to facilitate the circulation of the electrolyte, which is a solution of copper sulphate, containing a small amount of free sulphuric acid. The vessels, or electrolytic baths, are connected with each other by lead pipes. The solution from the lowest vessel flows into a sump, from which it is pumped to the vessel at the head of the system, and is again allowed to circulate through the system. The variations of this process and the manner in which the refining of metals is now carried on, are wholly mechanical, and in no way is the original process changed or new principles introduced, although there are innumerable improvement patents in existence. The pioneers in the work of developing the electrolytic refining of copper are Siemens and Halske, of Berlin, through whose efforts the success of the process has been largely secured.

It may here be noted that the method described in the treatment of copper is applicable to the production of other metals: gold, silver, lead, zinc, nickel, etc. The Wallace Farmer patents, a description of which will be given later, have special application to this extension of the process of all metals, especially to nickel. In fact, the production of fine nickel from crude nickel anodes, using an electrolyte of nickel ammonium sulphate, is at present being carried out on the lines indicated for copper production, and the success attending refining has led to much experimental work on lines tending toward direct production of metals from ores or furnace products. This brings us to the second phase of electrolysis; namely, the direct production of fine metal.

Many experiments were made to solve this problem by using mattes or furnace products directly as anode material in a suitable electrolyte identically as in copper refining. It must be borne in mind that, in copper or metal refining it is very necessary for economic working to have a pure anode material. Even then the electrolyte will become so fouled by the accumulation of impurities that it becomes necessary to regenerate it. The question may naturally be asked here, if impurities accumulate with comparatively pure anode material, what will be the ratio of this accumulation, and what will be the effect in using an anode material containing from 10 to 95 per cent of impurities? Upon the answer to this question hinges the direct economic production of metal through electrolysis. A number of processes tend to answer this question, and we will speak of them in the order of their priority or date. First of these is the Marchese Process (D. R. P. No. 22,429, May 2d, 1882). This process was given a thorough trial by the Societa Anomima Italiana of Genoa. This company built a 125 horse power plant for a practical test, and after spending large sums of money came to the conclusion that the same was a failure. The method of working was as follows:

1st. The smelting of copper-bearing ores to matte of about 30 per cent copper and 40 per cent iron was accomplished by well-known methods.

2d. This matte was cast in plates (800 x 800 x 30 millimeters) by means of iron frames or molds, a strip of copper being at the same time cast into the matte to serve as connection. Later this strip of copper was supplemented by a copper wire gauze extending through the whole form. This was done in order to prevent a too rapid disintegration of the anode plate, and also to equalize the distribution of the electric current throughout the whole mass composing the anode.

3d. The cathodes, thin copper plates (700 x 700 by 0.3 millimeters) were suspended by copper strips from wooden rails extending over the bath.

4th. The electrical connection between the anodes and cathodes of a single bath and twelve baths were known as a multiple series. All the cathodes of one

bath were connected to one conductor, while all the anodes were connected with the positive conductor. The connection of the first to the second bath, and of the second to the third, and so on throughout the series, were made between the cathodes of the preceding bath and the anodes of the following bath.

5th. The baths were lead lined wooden vats (2,000 x 900 x 1,000 millimeters deep). Twelve of these vats set in the form of a terrace were connected to one machine.

6th. The electrolyte was composed of a solution of copper and iron sulphate, which was obtained by roasting ore and leaching the roasted product with dilute sulphuric acid. The circulation of the electrolyte through the series of baths was accomplished by means of lead pipes connecting the individual baths, the overflow from each entering at the bottom of the succeeding bath.

This process proved a failure from a financial standpoint and was speedily abandoned. The prominent reasons for this failure were the uneven disintegration of the anodes, polarization arising from the incrusting of the anodes with impurities and consequently a very high rise in voltage, and further an accumulation of impurities in the electrolyte.

Notwithstanding the failure of the Marchese process, certain experiments carried on in connection therewith developed valuable and interesting facts. The action of the electric currents upon iron salts, during electrolysis, was found to result in the production of ferric sulphate from ferrous sulphate. This fact was made the basis of a patent issued to Body in 1886. Although Body's process and apparatus were not limited to copper alone, but were made the issue or extraction and recovery by electrolysis of metals in general. This process is in reality the forerunner of what are at present the two principal processes for the recovery of metals from their solution; namely, that of Siemens and Halske, and that of Hoepfner.

Body's electrolytic vat consists of a square box made of Portland cement and covered with an acid and waterproof paint. Parallel to the four sides and some distance therefrom, are four tile plates so joined as to form a second box. The bottom of the outside box is composed of a carbon plate and is connected as an anode to the terminal of an electrical generator. The four tile plates composing the inner box are half the height of the outer box. Within the gap formed by the inner box and the bottom of the outer box is stretched a felt cloth or some form of a diaphragm. In the space between the two vessels the copper cathodes are suspended. The electrolyte, composed of a solution of a ferric salt in salt or sodium chloride, enters the bottom of the inner vessel. Upon the carbon plate is placed raw ore. The solvent action of the electrolyte, together with the action of the electric current, dissolves the soluble part of the ore. The electrolyte, after filling the inner vessel, overflows into the outer, and here the copper, which it has taken up, is deposited. The electrolyte is drawn off at the bottom of the outer vessel.

According to Body's specifications, as the electrolyte flows through a bath, the following reactions take place:

1st. The metals contained in the ore are brought into solution by the reduction of a ferric sulphate or chloride solution to ferrous sulphate or ferrous chloride.

2d. The dissolved metals are deposited upon the cathode.

3d. The nascent chlorine generated at the anode reconverts the ferrous salts into ferric salts, and the excess of chlorine dissolves more metal from the ore lying in contact with, or existing as part of the anode.

Body's process was improved by Siemens and Halske. The improvement consisted in having the reactions between ferric salts and the metal in the ores take place outside of the electrolytic vats, and independent of the electrolysis. Figuratively speaking, they stored up the work at the anodes in the electrolytic baths for immediate use outside of the baths. In their patent specifications they claim the following method of procedure:

Sulphide ores (copper bearing pyrites, etc.) are roasted at a low temperature in such a manner that the iron contained therein is mostly oxidized, while a part of the copper should be present as copper sulphate, another part as oxide, but by far the greater part as sulphide. The roasted ore is then leached with the solution flowing from the electrolytic decomposition vats. When this solution has dissolved as much copper as is possible and all the iron salts have been converted back again into the ferrous condition, the same is then returned to the electrolytic vats for copper extraction and reconversion of the ferrous salts to ferric salts. The solution is then returned to be used for further extractive purposes. This cycle continues until the solution becomes so fouled with impurities that it becomes necessary to purify the same. The chemical processes involved in leaching and electrolysis are represented in the following equations:

1.—$H_2SO_4 + 2\,CuSO_4 + 4\,FeSO_4 = 2\,Cu + 2\,Fe_2(SO_4)_3 + H_2SO_4$.

2.—$x\,H_2SO_4 + Cu_2S + 2\,Fe_2(SO_4)_3 = 2\,CuSO_4 + 4\,FeSO_4 + S + x\,H_2SO_4$.

3.—$CuO + H_2SO_4 = CuSO_4 + H_2O$.

4.—$3\,CuO + Fe_2(SO_4)_3 = 3\,CuSO_4 + Fe_2O_3$.

5.—$CuO + 2\,FeSO_4 + H_2O = CuSO_4 + (Fe_2O_3 + SO_3) + H_2$.

If we compare reactions 1 and 2, we will immediately see that, provided all the copper in the ore exists as copper sulphide ($Cu_2S$), the solution after lixiviation contains exactly as much copper sulphate, iron sulphate, and sulphuric acid (reaction No. 2) as the solution before electrolysis has taken place (reaction No. 1). In other words, the electrolyte is completely regenerated, and can be used as such.

From reactions 3, 4 and 5 it will be seen that if the ore contains copper oxide, the solution will contain more copper, less iron, and less sulphuric acid.

It is hardly necessary to state that copper matte may be used instead of roasted ore. In this case, more iron will be brought into solution, and it becomes a difficult technical proposition to obtain solutions of the identical chemical composition. It may here be noted that in the electrolysis of the above solution, provided a good and rapid circulation exists, hardly any polarization is found to take place, and the potential difference of a bath remains constant at 0.7 volts for the same current density, as when refining with matte or soluble anodes requiring about 1.5 volts for the decomposition of the anodes and the decomposition of copper.

The electrolytic bath used by Siemens and Halske consisted of a shallow wooden vat, containing a false bottom. Upon this bottom is placed the anode, which is in turn connected with the terminal of the dynamo through an insulated cable. The anode is composed of gas retort or artificial carbon, either in plates, rods or broken pieces. If the broken pieces are used, they receive a bedding composed of perforated lead plates. On, and covering the anode, is placed a diaphragm or filter composed of felt or some other suitable substance. The space over the filter or diaphragm, known as the cathode chamber, contains the cathode in the form of a revolving cylinder, being a cylinder of wood covered with a thin sheet of pure metallic copper, which in turn, through brushes and the like, is connected to the other machine terminal. The cathode cylinder can be revolved slowly by means of suitable gearing or power transmission. The copper containing electrolyte flows into the cathode chambers in such quantities that the cathode cylinders are at all times covered by it. By rotation of these cathodes, the cathode solution is kept in constant motion or circulation. The electrolyte passes through the filter or diaphragm and fills the anode chamber, whence it is drawn off from this space formed through the false bottom. The inflow is kept constant with the outflow, thereby securing perfect circulation. The electric current enters the bath through the anodes and leaves it through the cathodes. At the cathodes the electrolyte gives up about two-thirds of its copper contents, while at the anode an equivalent quantity of sulphuric acid ($SO_3 + O$) is liberated. The electrolyte, partially freed from its copper, flows through the filter into the anode chamber, where the ferrous sulphate, formed in the leaching of the ore, is reconverted in ferric sulphate by the sulphurous anhydride liberated at the anode. The ferric sulphate solution, on account of its higher specific gravity, sinks to the bottom of the vat and is there withdrawn, to be again used for leaching purposes. The potential difference of a bath is claimed to be 0.7 volts at 16 amperes per square meter of cathode surface. Within the last four or five years, extensive mechanical improvements have been made in conjunction with this process.

With the above process it is possible to bring into solution copper and nickel bearing materials on identically the same line as copper alone, enabling to produce copper and nickel from ores and furnace products (mattes, etc.), containing both. Since copper is deposited at a different potential difference from that required to deposit nickel, it becomes possible to separate the copper from the nickel contained in the electrolyte, producing thereby a solution of nickel, iron sulphate, from which nickel can be separated either as a salt by displacement, or produced electrically in the metallic condition. It has been found that copper chloride acts similarly to ferric sulphate or chloride, in many chemical reactions—it undergoing oxidation and reduction, and a change of valence very similar to that observed in iron salts. This property of copper salts was introduced as an improvement over the Siemens and Halske process, and we have in this the fundamental principle of the Hoepfner electrolytic process. As in the Siemens and Halske process, we have the extraction of ores or metal bearing products with cupric chloride. The cupric chloride reduces to culprous chloride the same as ferric sulphate or chloride to the ferrous condition. While the cupric chloride is being reduced, an equivalent amount of metal from the product to be leached is dissolved. The process as carried out in practice is as follows: Ore, mattes, or other furnace products, are pulverized. This finely-ground product is treated with a hot solution of chloride, associated with salt, or saline chloride solution. The cupric chloride solution should contain from 60 to 75 grammes of copper per liter. The leaching is performed either in suitably-constructed revolving drums or cylinders, or by means of a jet of superheated steam acting upon the pulverized ore product and leaching solution in specially constructed vessels. (This improvement was devised and introduced by the writer while in Europe in 1896.) By this means the cupric chloride solution is converted into cuprous chloride, dissolving an equivalent amount of copper from the material to be leached. If the cupric chloride solution contains 60 grammes copper per liter before leaching, after leaching it will contain theoretically 120 grammes of copper per liter. This ratio is very nearly attained in practice. If the ores or mattes contain silver, gold, nickel, cobalt, etc., the same will go, in equivalent amounts, into solution, producing a complex chloride solution. This solution, after arriving at normal temperature, is ready for electrolysis. By submitting this solution to electrolysis, using copper electrodes, it is possible to drive all the silver, gold and precious metals out of the solution. (Improvements devised and introduced by the writer in 1895.) According to Dr. Hoepfner, to establish between electrolysis and lixiviation of ores a process constituting a true cycle, it is necessary to have the original lixiviating liquid produced by electrolysis and the original electrolyte reproduced by chemical process.

For the successful carrying out of this scheme the arrangement of the baths, the chemical composition and the circulation of the electrolyte become of the highest importance. In carrying out his process (D. R. P. 53,782, March 1888) he employs baths or a system of baths divided by diaphragms into two compartments. One compartment contains anodes which cannot be dissolved by electrolysis or nascent chlorine and the other compartment cathodes of pure sheet copper.

A solution of halogen salt and cuprous chloride circulates by itself past the anodes and a similar solution flows past the cathodes. At the cathode metallic copper separates, and at the rate of 2.36 grammes for each ampere hour, or twice as much as is deposited by unit current when a solution of an oxide salt is used, viz., copper sulphate.

At the anodes free chlorine would be produced if no cuprous chloride were present at this point, and a voltage of 1.8 volts would be necessary at the poles of the bath.

The chlorine, however, combines in the nascent state at once with the cuprous chloride which should be present to form cupric chloride. By this means a depolarization is produced which experience has shown amounts to about one volt. The electrolysis therefore practically proceeds with a potential difference of only 0.8 volts per bath.

Cuprous chloride ($Cu_2Cl_2$) develops in its formation 65.75 calories. Now as 45 calories of heat thus developed correspond to one volt of electromotive dissociating power, $65.75 \div 45 = 1.46$ volts is that electromotive force in volts which is necessary for decomposing cuprous chloride into 2 copper and 2 chlorine atoms. $Cu_2Cl_2 = 2\,Cu + 2\,Cl$.

In order to overcome this resistance in practice the tension must increase to about 1.8 volts, as with 1.46 volts the dissociating and combining power only just balance each other, so that quantitative decomposition cannot as yet take place. When, however, chlorine in a nascent state oxidizes cuprous chloride to cupric chloride the following reaction occurs: $Cu_2Cl_2 + Cl_2 = 2\,CuCl_2$. As cupric chloride ($CuCl_2$) represents 125.4 calories, 125.42—65.75 or 59.67 calories become free and help the work of the depositing current. Theoretically, therefore, according to Hoepfner, electrolysis commences when applying only 65.75—59.67 = 6.08 calories, or 0.13 volt.

The liquor at the cathodes, while successively flowing past a number of cathodes, gradually loses all its copper and leaves the electrolytic bath to be later on brought back into the process for completing the cycle. The liquor at the anode retains its full copper contents, but in the state of cupric chloride instead of cuprous chloride. At the electrodes the following reactions take place: $Cu_2Cl_2$ gives 2 Cu at cathode, while by electrolytic displacement the chlorine travels to the anode and combines with the cuprous chloride to form cupric chloride ($Cu_2Cl_2 + 2\,Cl = 2\,CuCl_2$).

The solution of the cupric chloride coming from the anodes is then employed for extracting copper, etc., from ores, mattes, and the like. In copper ores containing sulphide of copper the following reaction takes place: ($CuCl_2 + CuS = S + Cu_2Cl_2$) ($2\,CuCl_2 + Cu_2S = S + 2\,Cu_2Cl_2$.) This shows that the cuprous chloride formed has taken up as much copper as had previously been precipitated by electrolysis as metallic copper. As compared with the quantity of copper the concentration of the liquor is now twice as great as originally; in order, therefore, to establish the original concentration the cathode liquor which has been electrolytically deprived of its copper and flowing from the cathode cells is added thereto. It will be seen that the above constitutes a continuous process forming a complete cycle. The cycle is distorted by the gradual dissolution of iron, arsenic, antimony and the like impurities contained in the ores or mattes which become dissolved in place of copper. This defect, however, is overcome by the removal of such impurities, more especially the iron, by the purely chemical method through the use of oxide of copper before conveying the cathode liquor to the baths.

Simultaneously with the iron, arsenic, antimony and bismuth disappear. The advantages of this process according to Hoepfner are: 1st. Twice as much copper is produced from chloride solution as from sulphate with the same expenditure of energy. 2d. The halogen salts of alkalies and earth alkaline metals (especially calcic chloride) possess such a dissolving capacity for cuprous chloride that in case of solutions free from iron, concentrations can be effected which cannot even be remotely obtained with sulphate solutions. From this it follows that the slighter volume of liquid used in the Hoepfner process enables a smaller plant to produce the same quantity of copper as a much larger plant using sulphate solutions.

An acid solution of cupric chloride in calcium chloride is a very powerful solvent of many metals. If the solution contains free chlorine, gold, silver and allied metals are readily brought into solution, and through proper means can be readily recovered from such solutions independently. In properly constructed divided baths, having a perfect circulation of the anode and the cathode portions of the electrolyte, the writer has obtained from cuprous chloride solutions a quantity of copper comparing very favorably with the best electrolytic copper produced from sulphate solution. The voltage necessary did not exceed one volt per bath. Therefore one horse power day, at the rate of 700 volt amperes to the horse power, produces 39.6 kilometers or 87 pounds of pure copper to the horse power. This is double what can be obtained from sulphate solutions.

Cohen cites a very interesting experiment in the electrolysis of cuprous chloride without diaphragms. He noticed that in the electrolysis of chloride solutions at a low current density the solution of cupric chloride, regenerated at the anode, sinks to the bottom of the vessel containing it, on account of its increase in specific gravity, and there forms a definite rising stratum. If the copper cathode be of sufficient length to reach this stratum copper will be dissolved from the same. By employing a very deep bath this difficulty is overcome. His method was as follows: A deep vessel, having a sump in the bottom thereof, a long carbon anode extending into the sump, a siphon removing the solution from the sump, a short copper cathode reaching about half way down the bath and an inflow to supply perfectly reduced cuprous chloride solution. Cohen claims that with this apparatus a current density of 20 amperes per square meter cathode surface, and a potential difference of one-half volt per bath, he has obtained copper equal in all respects to the best copper produced by any known process. According to Cohen's claim, it would be possible figuring 700, instead of 730, volt amperes to the horse power, to produce 79.2 kilometers, equivalent to about 174 pounds of pure copper to the horse power day. Theoretically the above is possible, but the

writer thinks that practically it would be very difficult to attain any such results.

If copper nickel ores or mattes are used in the Hoepfner process after removing the copper, a solution coming from the cathode compartments of the bath will be obtained containing all the nickel, cobalt, etc., in the original electrolyte. This solution upon purification by the removal of iron, cobalt, etc., electrolyzed in proper baths, will yield nickel and free chlorine gas. The chlorine gas coming from the nickel electrolysis is in the Hoepfner process reabsorbed by a cuprous chloride solution to be further used in extracting more metal from ores and mattes, or it may be condensed into liquid, or absorbed by lime to produce bleach. The electrolysis of nickel chloride reverts back to a simple chloride solution ($Ni\ Cl_2 = Ni + Cl_2$), and for every 59 equivalents of nickel deposited there will be 71 equivalents of chlorine gas set free. The electrolysis of a nickel chloride solution is a simple and elegant technical proposition. Practically about six kilometers or thirteen pounds of nickel are produced by one horse power day. This yield is accompanied by the liberation of about 15 pounds of chlorine gas, yielding 45 pounds of 35 per cent bleach. Sulphate and chloride solutions are of such a nature that one can almost say that what is possible with the sulphate solution is also possible with the chloride solution. It is in fact just as easy to refine from a chloride solution as from a sulphate. It is therefore possible to produce copper and nickel or any other metal from a chloride solution at the same time using a soluble anode. The electrolysis of a salt or sodium chloride solution in the presence of a soluble copper and nickel anode producing thereby a solution of copper and nickel chlorides and alkali (caustic soda), was introduced by the writer as a part of the chloride process for producing metals (1898), that is solutions of metallic chlorides from copper, nickel ores, mattes, etc.

The electrolysis of a salt solution having as an ultimate object the production of caustic together with metallic chloride was made the basis of a patent issued to Faure, Eng. Patent No. 1,742, in 1872, and again Trickett & Noad, Eng. Patent No. 7,754, 1888. (For further particulars see Electrolytic Alkali Industry, George Lunge, Vol. 3.)

Little was known regarding the production of electrolytic nickel prior to 1840. At that time an English patent was granted claiming the recovery of nickel from the solution of the double cyanides. This patent had little value. But of greater importance are the researches of Böttger, who established the conditions upon which the production of pure nickel from nickel ammonium sulphates or chlorides depend. This suggestion toward the production of pure nickel was made the object of a patent by Andree, November 1, 1877. According to Andree, nickel ores or mattes or nickel-cobalt-copper combinations, either as sulphides or arsenides, are connected with the positive terminal of an electric generator and suspended as anodes in dilute sulphuric acid. Upon the cathodes only pure copper would be deposited, while the nickel going into solution remained in solution as long as the electrolyte remains acid. Toward the end of the operation, carbon anodes replace the matte anodes and all the copper is forced out of solution, leaving an electrolyte of nickel sulphate with iron sulphate. To electrolyze this solution the same is displaced or made alkaline with ammonia, the precipitated iron separated by filtration and the resulting nickel ammonium sulphate solution electrolyzed producing thereby pure nickel. About ten years later, in April, 1888, Farmer applied for a patent upon an apparatus having for its object the production of sheet metal and the refining of crude nickel. Farmer uses a revolving drum placed in a vat containing an electrolyte of nickel ammonium sulphate, chloride or nitrate. The anode of the bath is composed of a semi-cylinder of impure nickel placed below the drum with its curvature in the direction of the drum or cathode. The cylindrical cathode revolves, thereby agitating the electrolyte, while at the same time the nickel is deposited by means of the electric current passing through the same. It is difficult to electrolytically separate from crude nickel the metals which contaminate it. A patent was issued to Basse & Selve in 1891, having for its object the separation of nickel from iron, cobalt, zinc, etc. To accomplish this a neutral or weak acid solution, containing nickel, cobalt, iron, zinc, etc., is treated with a sufficient quantity of an organic substance to prevent the precipitation of nickel, iron, etc., through alkalies. Concentrated caustic is added to slight excess, and the resulting solution electrolyzed. At a current density of 0.3 to 1.0 amperes per square decimeter of cathode service, iron, cobalt and zinc separate at the cathode, the nickel remaining in solution or partly separates as hydroxide. If the current density is large and the solution strongly alkaline, nickel will also separate as hydroxide at the cathode. In order to obtain the nickel from the purified solution the solution is treated with carbonic acid or ammonium carbonate to convert all free alkalies into alkali carbonates. The solution is then again submitted to electrolysis. The organic compounds used for the above purpose are tartaric, citric, acetic acids, glycerine, dextrose, etc. The writer has obtained very good results in this direction by the use of creosote sulphonic acids, made by treating phenoles, obtained from coal tar with sulphuric acid.

The much-patented double decomposition arising when a solution of sodium chloride is electrolyzed in the presence of soluble anodes, carrying metals capable of forming chlorides, has again been made the basis of a patent granted to Frasch in 1901. The Frasch process was supposed to be an improvement on the Hoepfner process and was expected to supercede it and completely revolutionize all methods involved in the electrolytic production of metals. Much was claimed for the process by the inventor, but little has been realized, as the result of its work at Hamilton, Ont., show. Sufficient critical comment upon the Frasch process has appeared within the past year to make further details regarding it unnecessary here. It is the writer's opinion that the patent for the Frasch process was granted as the result of the exertion of a shrewd patent solicitor rather than the public recognition of an invention containing new and original ideas on the subject of electro-metallurgy.

Hoepfner's process, or rather the legitimate electrolysis of chloride solutions, is a commercial success, as is evident from the fact that, first, the Papenburg Works in Europe continue to operate the same; second, the Canadian Copper Company are daily producing a ton or more of metal from chloride solutions, and, third, zinc production from zinc chloride, which is technically a much more difficult problem than nickel from nickel chloride, is successfully carried on at present at the Brunner-Mond works in England. It stands to reason, therefore, that the failure of the Frash process, judging from results at Hamilton, must be explained in other ways than in the technical difficulties surrounding the electrolytic decomposition of a chloride solution.

In the production of metals by the Hoepfner or by the Siemens and Halske process the question of diaphragms is an important one. The reactions occurring at the cathodes are always of a reducing nature, while those at the anodes are always of an oxidizing nature. The result is that the electrolyte surrounding the anodes is of a different chemical nature

Fig. 2.—ALCOHOL INCANDESCENT LAMP FOR LANTERN PROJECTIONS.

from that surrounding the cathodes, and it becomes necessary, therefore, to keep the electrolytes separated by a substance having the property of allowing the individual ions to pass, but at the same time preventing the anode and cathode solutions from mechanically mixing. In the earlier experiments felt, cotton cloth, jute, parchment paper, etc., etc., were largely used. Hoepfner uses nitrated cotton ducking to advantage. In recent times porous tiling and the like (porous cup material as used in two liquid or primary elements) has come extensively into use. The writer is informed that the Canadian Copper Company is using this substance at the present time in the construction of its baths. The Pukall porous cups and diaphragms manufactured by the Royal Berlin Porcelain Company of Europe, are coming into extensive use. Asbestos cloth, mineral wool, spun glass, sand, cements, etc., etc., in almost every conceivable form and combination, have been patented for the above purpose. Although there are innumerable patents, good, bad and indifferent, affecting the manufacture and use of diaphragms, very few of them give satisfactory results.

From what has been said it will be seen that the electrolytical production of nickel and copper as at present carried on reverts back to two fundamental methods, namely: 1st. The production from sulphate solutions; and, 2d, the production from chloride solution, and any variations of method claiming to introduce new and original ideas or novelties are more of a mechanical than a chemical nature. It was the intention of the writer to furnish a list of patents on this subject, but the number is legion, and it was thought better not to cumber this paper with information which can be had from the Patent Office. In fact, the chemical and mechanical part of electrolysis has been so many times patented that doubt is thrown upon the merit and validity of each and every patent of this nature now upon the market. The question continually arises: Which of these patents are good, and to whom should the producers of metals pay royalties? So uncertain is the answer to these questions that resort is more and more made to the courts, and pending their decision capital is tied up and production stopped, and a new element added to the uncertainties of metallurgical and mining operations which should be as positive in operation as they are scientific in method.

## ALCOHOL LAMP AND MIROGRAPH PROJECTION APPARATUS.

Photographic projections, which are merely an improvement upon those made by the old magic lantern, cannot be satisfactory unless a person has a very dark room, a good screen and a proper source of light at his disposal. The first is easy to be had, as a general thing, since this kind of diversion is in most cases indulged in in the evening; but the screen often leaves much to be desired. If we operate by reflection, it is usually too transparent, and if by transparency, it is almost always too opaque. In the first case, that is to say, where the spectators are placed between the screen and the lantern, a white wall is the best thing that can be utilized. A linen or cotton sheet or table cloth allows of the passage of much more light than might be supposed, and that is so much lost for the spectator. A cloth painted with zinc white or white lead forms an excellent screen.

In cases in which the spectator is to see by translucency, that is to say, when the screen is placed between him and the lantern, the best results are given by ground glass or dioptric paper (tracing paper). As these are inapplicable for large sizes, the operator has to be content with fine linen, which has the inconvenience of permitting a spectator placed in the vicinity of the axis of the objective to see the lantern through the fabric. Finally, no matter how fine the fabric be, its translucency always allows much to be desired. These inconveniences are remedied in part by wetting the screen; but this is a complication. The amateur, who has no need of doing great things, and is readily content with an image five feet square, will, by preference, employ tracing paper, which is manufactured of indefinite length, but of a width that does not exceed five feet.

This question of screens is especially important when a person has not at his disposal a powerful light, like the arc lamp, and has to utilize all the light that he can possibly obtain. The lamps that give good results, aside from electric and oxyhydrogen ones, are not numerous, especially such as can be installed almost anywhere that the amateur desires. So we think that we shall be doing the latter a service in making known the arrangement adopted by MM. Reulos and Goudeau, for their apparatus for making animate projections with the mirograph. Their lantern (Fig. 1) is arranged in such a way as to receive an arc lamp or an oxyhydrogen or oxyetheric blow pipe; but, when electricity and gas are wanting, they make use of the Auer mantle raised to incandescence by an alcohol blow pipe. Domestic lamps based upon this principle have been in existence for some time, but it would be erroneous to think that their luminous intensity can be utilized completely in a projection lantern. What is necessary in such a case is a very small mantle that gives a very brilliant point of slight extent and that can be placed in the focus of the condenser. Any light emanating from the other points is useless. This was well understood by MM. Reulos and Goudeau when they arranged their lamp (Fig. 2). The reversion is flat and provided with a flange that is adapted to the slide of the lantern. The blow pipe is arranged in such a way as to support a very small mantle that gives a very luminous point, the brilliancy of which may be further increased by giving a slight pressure by means of a rubber bulb fixed to the screw plug of the reservoir. The ignition is very easily effected by pouring a little alcohol into a circular gutter situated near the top of the blow pipe. At the expiration of one or two minutes the latter will operate and incandescence will be produced. The lamp, *L*, is then introduced into the lantern (Fig. 1), and its distance from the condenser, *C*, is varied until there is obtained a maximum of illumination of the image placed in the mirograph, *M*, which is fixed upon the same board, at a proper distance from the lantern, and is provided with an objective, *B*, of wide aperture. When it is seen upon the screen that the illumination is very uniform, the intensity is increased by pressing the rubber ball two or three times. This suffices to keep up the pressure for a length of time more than sufficient to cause the band to pass. Under such circumstances it is possible to make animate projections anywhere; and, if a translucent screen be used, the

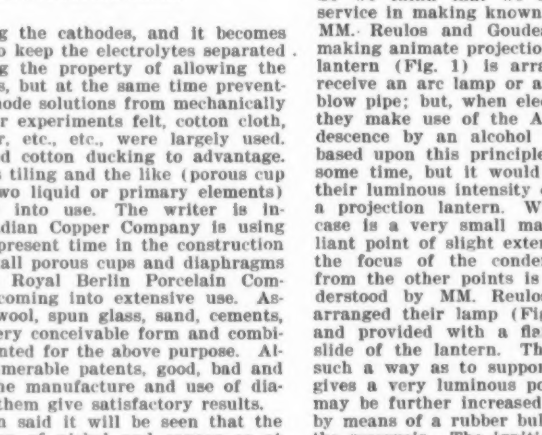



Fig. 1.—THE REULOS AND GOUDEAU MICROGRAPH LANTERN.

light will be amply sufficient. The alcohol has the great advantage over kerosene of giving no smoke or bad odor.—For the above particulars and the illustrations, we are indebted to La Nature.

## HORN LIGHTNING-ARRESTERS WITH IRON FRAMING.*

By Eugen Klein.

Lightning safety devices for electrical apparatus usually consist of a spark-gap connected between earth and the apparatus to be protected (see Fig. 1), and

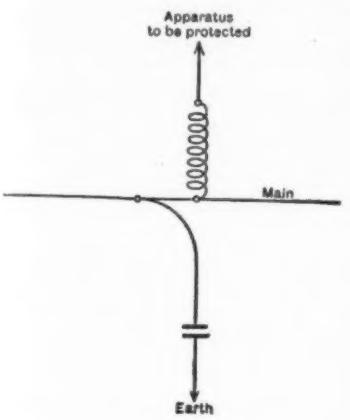



Fig. 1.

a few turns of copper wire placed in the connection to the apparatus itself. The atmospheric discharge, which is generally of an oscillatory character, then avoids the path containing the inductive resistance and passes to earth by means of the spark-gap. If power apparatus, such as a dynamo, is to be protected against atmospheric discharges, it is further necessary to provide for the prompt breaking of the connection to earth formed by the spark-gap.

Of the numerous instruments proposed for this purpose those constructed without moving parts deserve the preference. A special class of the latter consists

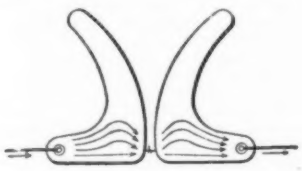


Fig. 2.

of those known as "horn" lightning-arresters, from their distinctive shape. We have to thank Elihu Thomson for their introduction, and he first employed the stream of hot air for blowing out the short-circuit arc. He, however, did not find this arrangement satisfactory, and, therefore, employed the electro-dynamic repulsion of an electro-magnet, excited by the short-circuit current, in addition.† The arc is driven upward along the horns, becomes longer and longer through the increasing distance between the plates, and finally breaks up.

In a new form of horn lightning-arrester‡ the use of the blast electro-magnet has again been resorted to. Oelschläger has so simplified the Thomson de-

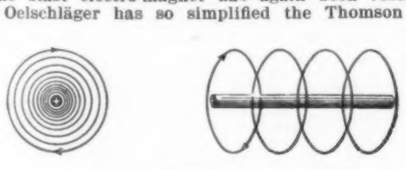


Fig. 3.

vice that a separate electromagnet is no longer necessary. The discharge plates are narrow and have such a shape that the spark-gap lies above the wires connecting the horns to the circuit. The electrodynamic action of the current in the horns on the arc then drives the latter upward. This lightning-arrester, manufactured by Messrs. Siemens & Halske, has been the one most commonly employed up to the present, because of its simplicity and handiness. Görges§ has pointed out why the form of horn chosen by Thomson is unworkable. It is clear that the greater part of the current-streams within the horns (Fig. 2) act unfavorably and drive the arc downward.

The writer has found that even with this Thomson

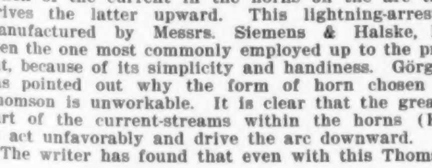



Fig. 4.

form of horn, which is commonly considered unsatisfactory, a very energetic expulsion of the arc can be insured by casing the horns in a suitable way with iron, and thus producing an unsymmetrical distribution of the fields surrounding the arc. In order to explain the action of such a lightning-arrester, let us consider the field produced in the air by a wire carrying current (Fig. 3). The field is arranged concentrically around the wire. Its strength at a point at a distance, $r$, with a current, $i$, is $H = 2\ i/r$. If a piece of iron is brought into the neighborhood of the wire, the field becomes distorted somewhat as in Fig. 4. The number of lines becomes increased; they lie partly in the iron, and, in attempting to shorten themselves still more, they exert a pull on the latter. This effect, which is already sufficiently well understood, is made use of here. On the principle of action and reaction the wire also becomes attracted by the iron and will tend to approach it. If now the part, $ab$ (Fig. 4), of the wire consists of an arc this will, in

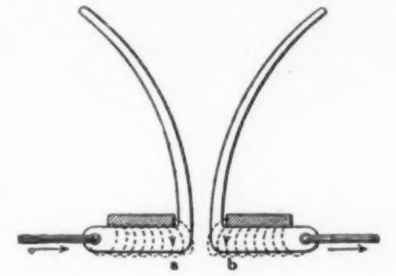



Fig. 5.

consequence of its small mass, experience a powerful acceleration toward the iron. Due to the presence of leakage, nothing will be altered if the iron be cut and opened out and the ends of the wire, $a$ and $b$, be provided with horn-like extensions, as shown in Fig. 5.

Should one wish to employ horns of the Thomson type, i. e., with very broad plates, the effectiveness of the iron plates, now laid more to the side, can be improved by means of added shoes, as in Fig. 6. By the addition of such shoes the shape of the horns can be altered at will; they are, in fact, all equally effective, as shown by tests. On this account the preference has been given to those forms employing large masses of metal, as these are more capable of dissipating the heat set up by a short circuit than are the thin wire horns, which are also liable to be bent

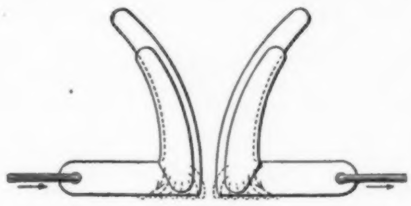


Fig. 6.

out of shape. The original Thomson form was, therefore, retained, but with the addition of an iron framing. One of the forms, as made for continuous and alternating currents by the firm of O. L. Kummer & Co., is shown in Figs. 7 and 8.

Tests.—The testing arrangements are shown in Fig. 10. The connections of the lighting-arrester are arranged as if the 500-volt 150-ampere traction generator were to be protected against a discharge artificially produced by means of the influence machine and battery. The dynamo circuit was given about 20 protective turns of copper wire. The gap between the horns was 3 millimeters. At first the iron framing was removed and the test showed that the short-circuit arc almost always remained stationary be-

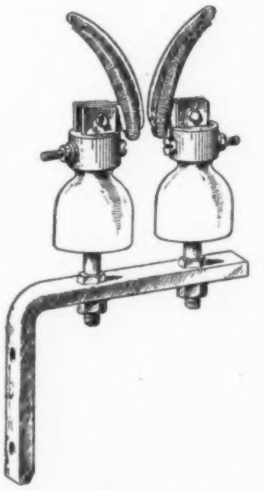


Fig. 7.

tween the horns. The iron shoes were next placed in position and then, almost without exception, the arc was driven upward very rapidly. The question as to what part the heated air took in the upward motion was next investigated, and for this purpose the observations were repeated with the horns in a horizontal position. In this case, again, the arc was blown toward the opening of the horns and extinguished with the same certainty and rapidity. Lastly, the horn-arrester was reversed, i. e., with the opening of the horns downward. Even then the arc was, without exception, driven downward and immediately extinguished, thus working in opposition to the blast of heated air.

Fig. 9 is an instantaneous view of the arc obtained in the above-mentioned test with a 500-volt continuous-current dynamo. The peculiar unsymmetrical shape, always obtained with continuous currents, is a purely polar appearance which reverses on changing the poles. The arc always rises more quickly at the negative than at the positive horn. After the test the negative horn is marked by a stroke running parallel to the inner edge; the positive horn shows a row of

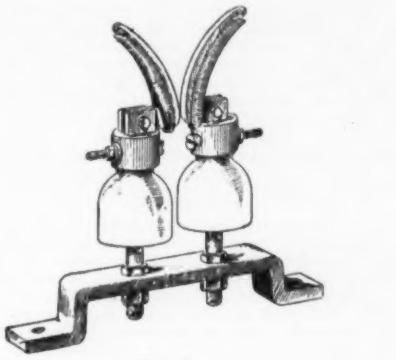


Fig. 8.

small dots which, under the magnifying glass, are seen to be minute fused globules.

With alternating currents the arcs are, on account of the continual reversal of the current, more symmetrical. They move upward by jumps sometimes, quicker at the right, sometimes at the left horn, in correspondence with the frequency, as can be plainly

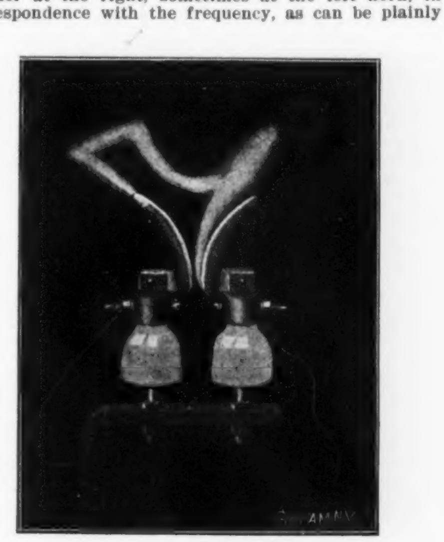


Fig. 9.

seen by the dotted stroke markings produced on the horns by the arc. These markings enable the speed of the upward motion to be determined if the frequency is known. With strong currents this became reduced to about the time of two alternations only.

In practice the horn lightning arrester has proved itself equally good for continuous and alternating currents. Short circuits to earth resulting from at-

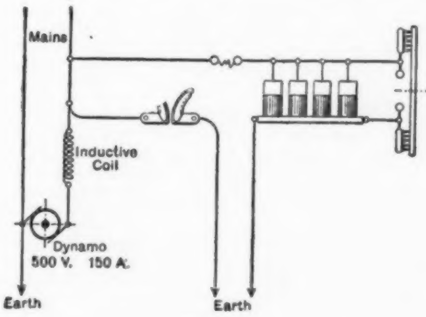



Fig. 10.

mospheric discharges were always immediately removed without causing any disturbance.

* From the Elektrotechnische Zeitschrift.

† American patent No. 321,464.

‡ Dr. Benischke, E. T. Z., 1901, p. 569.

§ Görges, E. T. Z., 1897, p. 214; German patent No. 91,133.

Reflection of Cathode Rays.—When a pencil of cathode rays impinges upon a surface some of the electrons penetrate into the surface and are absorbed. The number thus absorbed can be determined by measuring the charge communicated to the surface. The remainder are reflected, with the exception of a possible transmitted portion. The portion reflected may either have been turned back at the first encounter with the surface, or the particles may have penetrated some distance into the surface, having been deflected by central forces, and threaded their way out again. Both these reflected portions depend upon the angle of incidence, and the manner in which they depend upon it has been recently studied by J. Stark. The relation varies from metal to metal, as might have been expected, since some metals, like aluminium, absorb the electrons more easily on account of their large atomic volume. The reflected intensity of the first order increases with the angle of incidence, slowly at first, and then more rapidly, as the inter-

stices between the atoms of the surface diminish in apparent size. This increase is greater for the slightly-diffusing elements like aluminium than for the highly-diffusing elements like platinum. The same applies to the reflected intensity of the second order, but for a different reason. The additional increase of reflective power by polishing also increases with the angle of incidence. As regards the influence of the potential gradient, i. e., the velocity of the impinging electrons, the effect of a high velocity is to make them penetrate more deeply into the surface, and thus to increase their chances of absorption and to diminish the deflection. The reflected particles are also more nearly confined to paths indicated by geometrical reflection. Hence the reflected intensity diminishes with the speed, and the more, the greater the angle of incidence.—J. Stark, Physikal Zeitschr., May 15, 1902.

## NEW GREEN COLORING SUBSTANCE EXTRACTED FROM THE BLOOD OF ANIMALS POISONED WITH PHENYLHYDRAZINE.*

When animals, either warm blooded or cold blooded, are poisoned with 0.05 gramme to 0.0508 gramme of phenylhydrazine or of its chlorhydrate, their blood assumes the appearance of an emulsion, reddish brown in thick layers, and green in thin layers. As a consequence the thick muscles are colored reddish brown, and the thin muscles, as the pectoral, appear green.

The green coloring matter is not extracted directly from the blood of dead animals. When it is heated with mineral acids, especially with dilute nitric acid, the coagulated blood becomes green. The mass thus obtained resembles chlorophyl. The green color becomes the more intense in proportion to the interval of time between the poisoning and the death of the animal.

This green substance, for which I propose the name *hemoverdine*, is not, according to our present chemical knowledge, a product of reaction between phenylhydrazine or one of its derivatives and the acid employed, but rather a product of the metamorphosis of hemoglobine. The only known substance with which it can be compared is that which M. E. Fisher has obtained from a product of reaction between ethylic aldehyde and concentrated chlorhydric acid.

But the substance resulting from this reaction is not identical with hemoverdine, as M. Fisher has had the courtesy to say.

Besides the purely chemical differences between the two products, the distinction is manifest from their spectroscopic appearances. However, even if it were a similar product, and not a product of the metamorphosis of hemoglobine, it would not be less interesting to pursue the study of hemoverdine, for the other green coloring substance is formed only by the reaction of phenylhydrazine on free aldehyde, and the blood of poisoned animals does not contain it. At least, I have been unable to discover any trace of it.

In the course of my investigation I ascertained that when phenylhydrazine is added to the albumen of eggs, and the coagulated mass is afterward heated with concentrated chlorhydric acid, the liquid at length assumes a yellowish green coloration. From chemical and spectroscopic reasons the coloring matter thus formed is no more identical with hemoverdine than the green coloring matter of M. Fisher.

Small quantities only of hemoverdine are obtained when the defibrinated blood is mixed with phenylhydrazine. It cannot be procured in this way, either as rapidly or in as large quantities, as by the intermediation of the organism of poisoned animals. The intoxication of frogs, of rabbits, of Guinea pigs or of pigeons, either with aniline, or with paramidophenol, or with diazobenzol, or with sulphate or hydrate of hydrazine, does not determine the production of hemoverdine.

By the following process hemoverdine can be separated from the albumen of the coagulated blood, which retains it with great tenacity.

The green mass is dried on porous plates by means of the air, then extracted by alcohol or paraldehyde. It is purified, on recovering with pure paraldehyde the residue of the evaporation of the alcohol which has served for the extraction, leaving to repose for twenty-four hours, and decanting the green paraldehydic solution, which floats on a brown liquid containing the impurities.

Hemoverdine is also soluble in acetone, slightly so in ether, but insoluble in chloroform. The solutions are dichroic, green in thin layers, reddish brown in thick layers. The solutions leave an amorphous green mass on evaporation in the open air. Evaporation at the temperature of the wet bath furnishes a yellowish brown residue.

The spectrum of hemoverdine and that of the blood of animals poisoned with phenylhydrazine are not altogether identical, on account of the presence in the blood of unchanged hemoglobine, as well as of other products of its metamorphosis besides hemoverdine. There is nevertheless, a characteristic band of absorption common to the two spectra. It is situated in the yellow region of the spectrum, in the immediate neighborhood of the ray D of Fraunhofer, and notably longer than the corresponding band of oxyhemoglobine. Two other bands, much narrower, situated in the orange region of the spectrum, also characterize the spectrum of hemoverdine. They separate into two parts essentially equal to the space comprised between the rays C and D. These two bands are distinguished, although somewhat confusedly, in the spectrum of the blood of poisoned animals. Finally, a third band, perceptible only in the spectrum of hemoverdine, is situated to the right of the principal band, a little nearer to the middle of the space separating the rays D and E.

In fine, four bands characterize the spectrum of hemoverdine; the first situated in the orange region, at about a third of the distance separating the rays C and D; the second situated at the limit of the orange and yellow, at about two-thirds of the distance separating the rays C and D; the third, the most important, in the yellow region commencing at the ray D and extending to the right; the fourth, in the green nearly at half the distance separating the rays D and E. The space comprised between the principal band and those that accompany it on the right and the left is manifestly shaded, and the light almost completely absorbed, on and after the blue region.

This spectrum, therefore, differs radically from that of hemoglobine and its products now known, as well as from those of chlorophyl and the biliary pigments, whose relations with hemoglobine have been long sought for.

* From the French of M. Louis Lewin, Communication to the Académie des Sciences.

## ATTAR OF YLANG-YLANG.

With the acquisition of the Philippines, the United States government now becomes the chief producer of the celebrated attar of ylang-ylang, fully as exquisite and fully as precious as the much-praised attar of roses. The ylang-ylang tree attains a height of 60 feet and has drooping, greenish-yellow flowers 3 inches long and extraordinarily fragrant.

The popularity of the violet as the latest favorite in the list of perfumes is threatened by the attar of ylang-ylang of the Philippines. Colonia Agrippa, the choice perfume of the Romans, so named in honor of the wife of the Emperor Claudius, after enjoying in modern times an unrivaled lead for nearly two centuries as the eau de Cologne, from the city of the Rhine, the first place of its modern manufacture on an extensive scale, yielded to the more lasting fragrance of the sachet in evidence in all forms, in all places, and among all classes and conditions of women.

The attar of roses, the famed essential oil of the damask rose of Kazanlik, on the sunny slopes of the Balkans, finds its equal in perfume in the Philippine product, and the ylang-ylang tree is a better yielder of essence from the flower, and, therefore, a less costly basic essence for the perfumer's art.

The ylang-ylang, sometimes spelled ilang-ilang, while indigenous to many parts of tropical Asia, reaches its greatest perfection in the Philippine Islands, where it is a favorite among the natives. Besides its value as an attar in preparations for the hair and toilet waters, it is held to possess curative virtues in tooth and other aches and pains. In a preparation of cocoanut oil, known to commerce as Macassar oil, for the hair, the attar of ylang-ylang is the perfume.

The perfumers of Europe, and to a less degree of the United States, make it the base of some of their most costly extracts. The Manila oil is practically without competition in the markets of the western nations on account of superiority, and even at from \$40 to \$55 a pound the supply is unequal to the demand.

Hitherto the United States supply has come through Germany or France. Together with England, those countries have a monopoly of the product, which is generally secured in advance under contract for the entire output.

The tree is common to many localities south of Manila. It is found chiefly in the well-populated provinces and islands, and the natives say that it thrives best near the habitations of man. The propagation in plantations, by seed or cuttings, about twenty feet apart each way (108 trees to the acre), is easy, and the growth rapid in almost any soil. The first flowers appear in the third year, the eighth yielding as high as 100 pounds, the bloom occurring every month. The greatest yield is from July to December.

The process of converting the long, greenish yellow, fragrant petals of the flower into essence is by the simplest form of distillation, using merely water and the choicest flowers. No chemicals of any kind are required.

## DIRECT COMBINATION OF CHLORINE WITH CARBON.

Many gaseous compounds, according to W. v. Bolton in Zeits für Elektrochem, are decomposed by the action of the electric arc in closed vessels, and the behavior of hydrocarbons in this respect is utilized in the arts. Hydrochloric acid vapor may also be dissociated up to a certain point, at which recombination takes place with explosion. Carbon tetrachloride vapor, exposed to the action of an arc 4 millimeters long, playing between carbon poles with a current of 3.5 amperes at 57 volts, is also decomposed; the arc is unsteady, and its luminosity is small, and in one case the carbon points in three hours had burnt away to some extent, while a carbon deposit had formed on their edges and on the walls of the vessel, the deposit being thickest on those parts of the carbon where the temperature was highest. On opening the stopcock of the vessel, a strong smell of chlorine was observable. The arc was next passed between carbon poles in a stream of chlorine, prepared from manganese dioxide and hydrochloric acid. After six hours, with a current of 5 amperes and 43 volts, the carbons were found to have been burnt away a little, but no chlorine compound of carbon was to be discovered in the escaping gas. The laboratory vessel was therefore filled with pure dry chlorine gas, an arc was struck, the excess pressure produced by the expansion of the gas owing to the heating effect of the arc was removed by opening one of the cocks momentarily, and the arc was continued in the closed vessel, with a current of 5.5 amperes at 42 volts. After half an hour, a crystalline deposit was noticed at the lowest part of the glass vessel, and this increased, until after four hours, a crop of fine silky needles was formed. As no further increase in the crop was observable, the circuit was broken. It was found that the positive carbon had gained 0.0012 gramme in weight, while the negative carbon had lost 0.0252 gramme. The crystals melted at 225 deg. C., and contained both carbon and chlorine, and probably consisted of hexachlorbenzene ($C_6Cl_6$). By means of a modified apparatus, a larger crop of fern-like crystals was collected. In six hours, with a current of 6 amperes and 43 volts, 0.6 grammes of a crystalline substance with camphor-like smell, melting and boiling at 184 deg. to 186 deg., was obtained. Analysis and confirmatory tests showed it to be perchlorethane, $C_2Cl_6$, not $C_6Cl_6$ as found in the experiment with the smaller closed vessel. The positive carbon had after the experiment a smooth crater, while the surface of the negative carbon was covered with a number of symmetrical pittings of about equal size, giving the whole the appearance of caviare. Bromine and iodine appear to act in the same way as chlorine, but the experiments with them are still in progress.

## TRADE NOTES AND RECIPES.

**To Make Gas Rubber Tubes Tight.**—To prevent gas from escaping through rubber hose, it is covered with a mixture prepared as follows: Dissolve 5 parts of gum arabic and 3 parts of molasses in 15 parts of white wine and add, with constant stirring, 6 parts of alcohol in small quantities. Stirring is necessary to prevent the alcohol from precipitating the gum arabic.—Sueddeutsche Apothekerzeitung.

**To Impart the Aroma and Taste of Natural Butter to Margarine.**—In order to give margarine the aroma and flavor of cow butter Poppe adds to it a fatty acid product, which he obtains by saponification of butter, decomposition of the soap and distillation in the vacuum at about 60 deg. C. The addition of the product is made upon emulsification of the fats with milk. The margarine is said to keep for months.—Chemiker Zeitung.

**Furniture Polish Which Does Not Effloresce.**—Kohn of Altona is said to obtain a non-efflorescent furniture polish by mixing 3 parts of spirit with 7 parts of benzine, to which mixture 8 grammes of benzoin and 16 grammes of sandarac are added to every liter. The compound is applied as a final polish to the previously polished pieces of furniture.—Pharmaceutische Centralhalle.

**To Clarify Turbid Orange Flower's Water** shake 1 liter of it with 100 grammes of sand which had previously been boiled out with hydrochloric acid, washed with water and dried at red heat. This process doubtless would prove valuable for many other purposes.—Neueste Erfindungen und Erfahrungen.

**Practical Utilization of Linseed Oil Sediment.**—Many dealers have found that linseed oil will form a sediment, upon long continued storing, regarding the utilization of which they are in doubt. This sediment, which principally contains mucilaginous parts that materially retard the drying of the linseed oil, constitutes, mixed with linseed oil varnish or the sediment of same, an excellent material for the production of putties, while owing to the slow drying it is less valuable for paints.

Linseed oil sediment is also very useful for the manufacture of barrel soaps, and is readily taken by the soapmakers, so that even large quantities can be easily disposed of.

Even the sediment which forms upon protracted storing of linseed oil varnish (boiled oil) can be made good use of. The sediment of linseed oil varnish consists partly of the mucilaginous parts eliminated in the boiling and partly of oxygen-transmitting substances partially or wholly reduced, and generally possesses considerable drying qualities. For this reason it is preferably employed for the production of dark oil paint and for putties. It may, like the sediment of linseed oil, also be used in the manufacture of soap, but the former use is decidedly the more lucrative.

Another way is to squeeze out the liquid ingredients by means of filtering presses, under strong pressure, and to use the press residue, ground up, as a coloring substance, or if a large quantity of lead compounds were used in the varnish, to obtain lead from it by reducing melting. The first named way of utilization, however, is more commendable, because it is simpler and it is not necessary to look for buyers of the residue.—Colonialwaaren Zeitung.

**"Siccatives,"** says the Dresden Farb. Ztg., "are substances or preparations without which no artist, polisher or varnisher, and no painter can work. They serve, as everybody knows, as an addition to paints, colors, varnishes etc., to hasten the drying of these substances when applied. Some of those now in commerce are most excellent preparations, but some of them, unfortunately, are all but worthless."

The writer then goes on and describes the qualities necessary to a good siccative, and finally gives the following as among the best now in commerce:

1. Old linseed oil, 24 parts, is warmed, and to it is added 5 parts of lead oxide and 1.50 parts of calcined lead acetate, then it is brought to a boil and boiled until a sample taken from it strings out into long fine threads. It is then removed from the fire, and 40 parts of turpentine oil is added, or more if it is wished to be still thinner.

2. Six parts of old (stock) linseed oil is heated with 0.3 part of manganese carbonate, at a temperature of about 280 deg. C., until it behaves in the manner stated in the foregoing paragraph. Remove, and thin with 12 or more parts of turpentine oil.

3. American rosin, 2 parts and 6 parts of clear linseed oil are heated together until the rosin is melted and dissolved in the oil. Add 0.75 part of lead oxide (litharge) and 0.2 part of calcined lead acetate. Now raise the heat, adding 0.05 part of manganese carbonate and let boil until, when tested, a drop on a plate of glass becomes hard, and if scraped away comes off brittle, or behaves in the manner first stated.

4. American rosin 3 parts and 3.5 parts of stock linseed oil are heated as before until the rosin is taken up by the oil. Add 1.1 parts of litharge and 0.3 part of calcined lead acetate, and raise the heat to a boil. when boiling commences add 0.05 part of manganese carbonate and boil until it tests as above.

5. American rosin 2 parts, and 3 parts of linseed oil are warmed until the rosin is taken up. Add 0.75 part of litharge and 0.2 part of calcined lead acetate. Bring to a boil and add 0.10 part of manganese carbonate and treat as before.

The preparation of siccatives with manganese, in my opinion, adds the writer, is constantly on the decrease. In the first place this substance makes the product very dark, nearly black, in fact, and besides, it has the disadvantage of separating from varnishes that are prepared with resinates of lime, or if this does not happen, of thickening, when rubbed up with colors.

## TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

**Trade Opportunities in Finland and Germany.**—The following letter, which has been received at the Berlin consulate from Bjorneberg, in Finland, is respectfully commended to the attention of American shoe manufacturers who are seeking to extend their export trade to new markets:

"Bjorneberg, June 28, 1902.

"To Consul-General Mason, Berlin:

"I see from the technical paper the Ledermarkt, of Frankfort-on-the-Main, that you are interested in the export of ready-made shoes from America, and I permit myself to ask for the address of two American shoe exporters or manufacturers.

"American shoes are not yet imported into Finland, and, as I am interested in the matter, I would like to see what can be done with them.

"Thanking you, Mr. Consul-General, in advance,

"I am, very respectfully yours, Jacob Raad."

Two articles for which there is an active and reliable demand in Germany are sulphate of copper (blue vitriol) and flake graphite. Any American exporter having either or both of these materials at command can find a ready agent for Germany by applying to Oskar Pascheles, 24 Gänsemarkt, Hamburg.—Frank H. Mason, Consul-General at Berlin.

**Trade-Marks in Honduras.**—Consul W. E. Alger reports from Puerto Cortes, July 8, 1902:

The Apollinaris Company, of Germany, made application last February for registry of trade-mark for its mineral waters. The result of the petition is a decree, of which I give herewith a translation, believing it will be of interest to American manufacturers to learn that they can now protect their products against imitations in Honduras:

DECREE.

The National Congress, taking into consideration the necessity of a law regarding trade-marks, decrees the following:

LAWS OF TRADE-MARKS.

Article 1. Any sign which determines for commerce the specialty of an industrial product is considered a trade-mark.

Art. 2. The form, color or designations which of themselves do not constitute a determining sign of the specialty of the product are not considered as trade-marks. In no case will an immoral sign be allowed.

Art. 3. Any proprietor of a trade-mark, be he a native or a foreigner residing in the country, can acquire the exclusive right to use the same in the republic, subjecting himself to the formalities of the present law. Natives and foreigners who reside outside the country can register their trade-marks if they have in the country an agency or industrial or mercantile establishment for the sale of their products; this applies in regard to foreigners where treaties do not otherwise provide.

Art. 4. In order to acquire the exclusive right to a trade-mark, the interested party should present, either in person or by means of a representative, to the Secretary of Fomento a statement to the effect that he applies in accordance with his rights, accompanied by the following documents:

(1) Power of attorney from his principal (if the interested party does not present himself in person).

(2) Two examples of the mark, or representation of same by means of a drawing or engraving.

(3) In case the mark appears in relief or intaglio, or it presents any other peculiarity, two models which show these details.

(4) The written contract in virtue of which an agency has been established. This applies to article 3. This document must be duly legalized.

Art. 5. In the aforesaid presentation there must be expressed the name of the fabric, the place where it is made, the domicile of the proprietor, and the branch of commerce or industry to which the mark is to be applied.

Art. 6. A trade-mark belonging to a foreigner not resident in Honduras cannot be registered unless it has been legally registered in the country of its origin.

Art. 7. The first party who has made legal use of the mark is the only one who can legally obtain the same. In case of dispute between two parties claiming the same mark, it belongs to the first possessor; and if this cannot be proved, to him who first solicits registry.

Art. 8. The exclusive use of a mark cannot be had save by virtue of a declaration by the Secretary of Fomento that the interested party has reserved his rights after having complied with all legal requisites.

Art. 9. The declaration mentioned in the foregoing article will be made without previous examination, on the exclusive responsibility of the petitioner and without affecting the rights of a third party. The Secretary of Fomento will publish the petition of the interested party, and, in case of opposition presented within ninety days following publication, will not register the mark until a judicial decision has been rendered as to who is entitled to registry.

Art 10. Trade-marks are not transferable, except in connection with the establishment for which they serve, and such transfer is not subject to any special rules or formalities and is conducted according to the regulations of common law.

Art. 11. The duration of a trade-mark is indefinite, but it will be forfeited by failure of production for one year or more.

Art. 12. Facsimiles of trade-marks will be kept by the Secretary of Fomento, and anyone can obtain, at his own expense, a certified copy of same.

Art. 13. Any trade-marks not filling the foregoing conditions will, on request, be declared of no value.

Art. 14. The judge declaring void any trade-mark will send a copy of his decision to the Secretary of Fomento.

Art. 15. Trade-marks are false—

(1) When a copy of any legally registered trade-mark is used.

(2) When an imitation has some slight difference, but may be easily mistaken for the original.

Art. 16. Anyone will be considered guilty of the crime of counterfeiting, no matter where this may be committed, who has imitated a mark or made use of such imitation, in application to articles of the same industrial or mercantile nature.

Art. 17. The crime of counterfeiting a trade-mark is subject to penalties, as prescribed by the penal code.

Art. 18. Drawings and industrial models are included in the provisions of this law.

Art. 19. The protection which the present law gives to trade-marks does not extend to articles covered by them, except those made and sold in this country.

Art. 20. The present law goes into effect from the date of its promulgation, and all petitions which at that time are pending will be decided in accordance therewith.

Given in Tegucigalpa this 7th day of March, 1902.

**Eastern Markets for Cotton Goods.**—According to recent German reports, England has been, up to the present time, the main exporter of cotton goods to Egypt, although the Italian cotton industry is becoming a successful competitor. In 1900 12,819,915 yards of cotton cloths, valued at £235,650 Egyptian ($1,142,900), were imported into Egypt from the following countries:

| | Yards. |
|---|---|
| England | 5,625,266 |
| Italy | 2,838,733 |
| Germany | 1,543,933 |
| Austria-Hungary | 1,080,177 |
| France | 823,728 |
| Belgium | 394,179 |
| Turkey | 300,534 |

Among the German imports the cheap cotton prints were most important, these being manufactured chiefly in the Alsace-Lorraine country and shipped via Genoa, so that it is believed many of them appear on the Egyptian market as Italian goods. Lately, a more expensive stuff with a silk finish has gained considerable prominence in the market. Furniture stuffs are also in demand and are shipped mainly by Italy. It is important that these goods should possess a high gloss and luster and a soft feel to the hand.

At present a glut is reported in the market of plain, unbleached cotton stuffs, a large quantity of which is supplied by the United States, especially to the Sudan and the Red Sea region. Other articles extensively imported into Egypt are cotton shawls, net lace, tulle, gauze, mosquito netting, curtains and cotton head shawls. There is an especially good demand for checkered and many-colored cloths.

Among the Chinese in the vicinity of Hong Kong, there is a large and expanding market for cheap white cotton hosiery. The exportation of cotton goods to the East takes place largely through houses at points like Hamburg and Paris. There is no question that American manufacturers of cheap cotton half hose can find a market for their products, if the combination of colors which the Oriental people desire is carefully observed. Judging by the success of our manufacturers in the South American trade, their chances in the Orient ought to be exceptionally good. A correspondent wrote to me from Alabama some time ago that he was doing a good business with South America in hose, but he wished to learn the combination of colors which the German and French manufacturers were sending to those countries. I succeeded in getting him the exact information, and within a few years he has increased his business with South America from 14,000 dozen to 33,000 dozen per week. American manufacturers ought also to be able to compete in the East with English, French and German hosiery.—J. F. Monaghan, Consul at Chemnitz.

**New Railway Between Madrid and Bilbao.**—The department has received from Consul-General J. G. Lay, of Barcelona, and from Consul R. M. Bartleman, of Valencia, descriptions of the new railway between Madrid and Bilbao. Mr. Lay says:

A company has been formed under the name of the Compania Ferroviaria Vasco-Castellana, for the purpose of making a direct double-track railway between Madrid and the important northern seaport of Bilbao. Shares in the new enterprise are now being offered to the public.

The company seems to be a development of the Sierra Company, Limited, of London, England, which already holds the concession for 42 miles of railway, connecting its important mines in the provinces of Burgos and Logrono with the sea. This short railroad was primarily intended only for the transport of the company's minerals, but, on the urgent representations of the neighboring towns and of influential commercial bodies, it has been decided to convert it into a public railway and to extend it to Madrid.

The provincial council of Burgos has offered a subvention of 3,000,000 pesetas ($462,000) in cash, and the corporation of that city has voted 475,000 pesetas ($73,000) for the station buildings. Other provincial and municipal bodies have also promised pecuniary assistance and the grant of land, as it is recognized on all hands that the opening of the new line can not fail to greatly increase the prosperity of the entire district.

The saving in distance between Madrid and Bilbao will be 85 miles, and Bilbao will thus be made the nearest maritime port to the capital.

The line is to be finished and in working order within five years from its commencement.

The company will be legally domiciled at Bilbao, but the London address will be: The Sierra Company, Limited, 75 Lombard Street, London, E. C.

Much material of all kinds, besides rolling stock, will be required, and firms in the United States desirous of making offers should lose no time in doing so.

Consul Bartleman adds:

Preliminary work has already begun on the road, by far the most important opened in Spain in recent years, as it will place Madrid in direct communication with Bilbao, the chief seaport, mining, and industrial center in the north of Spain. The line will mark a distinct advance and a complete departure from Spanish railway traditions, not only in being a double track, but in the employment of the best materials, rolling stock, and appointments that modern industrial science can supply. The distance (261 miles) will be covered in about six hours. I inclose a map of the road.*

**Bicycles and Automobiles in Algeria.**—During the past few months I have received a number of inquiries as to the present conditions of the bicycle and automobile market, and the future prospects of American trade in this line in Algeria.

Algeria is a country specially adapted to the use of automobiles, both on account of its excellent roads and the steep grades which prevail. As far into the country as roads are built, they are constructed with great care and kept continually in repair. Many of them are military roads adapted for the rapid movement of soldiers, including, of course, artillery and munitions, the railroads being wholly inadequate for such purposes. Other roads are almost as good, owing to the necessity of bringing heavy loads of wine from the vineyards of the interior to the seaboard.

On account of the frequent and heavy grades, bicycles are not used here to the same extent as in more level localities. Bicycles are used and American makes are favored, but in my opinion the demand will never be sufficient to induce our manufacturers to make any great effort to control the market.

The city of Algiers has a population of 100,000, about one-half of whom are of Arabic descent and cannot be considered as possible purchasers. The other half, of European birth and descent, according to the best obtainable estimate, own 900 automobiles and 300 motocycles. The automobiles are exclusively of French manufacture. The makes are: De France, De Dion-Bouton, Darracq, Pankardt & Levassor, Chaudal, Morse, Renaud, George Richard, Hurtu, Rochet, Dietrich, Bolide and Gladiator.

American machines have never been tried here, and it is therefore impossible to give an opinion as to the future prospects for American trade. Aside from a natural prejudice in favor of France, and also the absence of customs duties upon the French article, there is no reason why automobiles manufactured in the United States should not be sold here as bicycles and many other machines have been sold.

Algerians are favorably disposed to American manufactures of all kinds, especially machinery.

At present freights from the United States to Algiers are very low. The newly established Levant Line gives bimonthly service between New York and Mediterranean ports. Application for rates should be made to the Hamburg-American Steamship Company, New York city.

The following are the names of prominent concerns dealing in automobiles: Vincent Gérin, rue Waïsse, No. 1; Le Gerrier, rue de Constantine, No. 50; Paul Mayeur, rue de la Liberté, No. 2, all of Algiers; Mentzer, Boulevard Seguin, 35; and Traut, Place de l'Evêché, Oran, Algeria.

All correspondence with the above firms and printed or descriptive matter should be in the French language, and French currency should be used in price lists.—Daniel S. Kidder, Consul at Algiers.

**Electricity for Cultivation of Plants.**—A Frankfort journal of recent date describes experiments made by Mr. J. Fuchs, a wine producer of Elba, in the use of electricity in grape culture.

He planted, some years ago, four fields with native grapevines, in the midst of a district infested with phylloxera, and treated two of these fields with "air electricity." The difference in the development of the grapes of the fields was apparent; those treated with electricity yielded better results, both in quality and quantity, and were not infected with phylloxera, while the other fields were.

Mr. Fuchs, says the journal, has demonstrated that electricity increases the fertility of the soil. It is not sufficient to simply conduct air electricity to the earth, but there should be a direct metallic connection of the electric conduit with the main stem of the plant. On a field of about two and a half acres five masts are erected, the tops of which are supplied with an arrangement for accumulating atmospheric electricity. These accumulators are connected with each other by wires. Wires are laid in the soil about one and a half feet deep, forming an evenly distributed metallic net. Every accumulator is connected with this metallic net by a wire running along the mast. Short wires connect with the plants, the free ends being stuck into the stem or into the main root thereof.

It is stated that if this method fulfills expecations, it will be a very important invention.—Richard Guenther, Consul-General at Frankfort.

**German Demand for Cast Spring-Steel Plate.**—Consul J. J. Langer writes from Solingen, July 10, 1902:

I have an inquiry from P. D. Rasspe Soehne, Solingen 2, Germany, manufacturers of iron and steel goods, for the names of United States firms making cast spring-steel plate, used in the manufacture of saws. I shall be glad to refer to the party in question any information I can obtain.

* Filed in the Bureau of Foreign Commerce, where it may be examined by parties interested.

### Index to Advance Sheets of Consular Reports.



The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

**Dandruff Cure.**—The treatment of that condition of the scalp which is productive of dandruff properly falls to the physician, but unfortunately the subject has not been much studied. Some time since a writer in the Louisville Medical Monthly stated that having suffered much inconvenience from dandruff, and tried many nostrums and other preparations for its relief, he at last found a cure in a sulphur lotion made by placing a little sublimed sulphur in water, shaking well, letting settle and washing the head every morning with the clear liquid. After discontinuing the treatment for eighteen months there had been no return of the trouble.

Sulphur is said to be insoluble in water; yet a sulphur water made as above indicated has long been in use as a hair wash. A little glycerin improves the preparation, preventing the hair from becoming harsh by repeated washings.

The exfoliated particles of skin or "scales" should be removed only when entirely detached from the cuticle. They result from an irritation which is increased by forcible removal, and hence endeavors to clean the hair from them by combing or brushing it in such a way as to scrape the scalp are liable to be worse than useless. It follows that gentle handling of the hair is important when dandruff is present.—Drug Circ.

**Tooth Wash.**—

| | | |
|---|---|---|
| White castile soap | 1 | ounce |
| Alcohol | 6 | ounces |
| Water | 6 | ounces |
| Glycerin | 2 | ounces |
| Oil of peppermint | 20 | minims |
| Oil of cloves | 10 | minims |
| Oil of cinnamon | 20 | minims |
| Oil of wintergreen | 30 | minims |
| Tincture of vanilla | ½ | ounce |

Dissolve the soap in the water by the aid of heat if necessary, and add the glycerin and tincture of vanilla. Dissolve the oils in the alcohol and add to the solution first formed. Then filter. Be sure the oils are fresh, and do not put in more than the quantities specified.—Druggists Circular and Chemical Gazette.

**New Polish for Harness Leather.**—

The Augsburg Seifensiederzeitung gives the formula for a new polish for harness leather which, it says, gives a "wonderfully beautiful, mild and lasting" finish. It is as follows:

| | |
|---|---|
| Ox-blood, fresh, clean | 1000 parts |
| Commercial glycerin | 200 parts |
| Oil of turpentine | 300 parts |
| Pine oil (rosin oil?) | 5000 parts |
| Ox gall | 200 parts |
| Formalin | 15 parts |

Mix in the order named, stirring in each ingredient. When mixed strain through linen.

**Corn Salve.**—

| | | |
|---|---|---|
| Salicylic acid | 2 | ounces |
| Ammonium chloride | 2 | ounces |
| Acetic acid | ½ | ounce |
| Lanolin | 2 | ounces |
| White wax | 2 | ounces |

Lard enough to make one pound.

Mix the acid with the ammonium chloride, add the lanolin, and, lastly, the lard and wax previously melted. Mix thoroughly, pour into tin boxes and allow to cool.—Druggists Circular and Chemical Gazette.

**Lavender Water.**—

| | |
|---|---|
| Oil of lavender | 3½ ounces |
| Oil of bergamot | 1 ounces |
| Tonka beans | 2 ounces |
| Alcohol | 6½ parts |
| Water | 1½ parts |

—Drug. Circ.

**Witch Hazel Toilet Cream.**—

| | |
|---|---|
| Quince seed | 90 gr. |
| Boric acid | 8 gr. |
| Glycerin | 4 fl. oz. |
| Alcohol | 6 fl. oz. |
| Carbolic acid | 6 dr. |
| Cologne water | 4 fl. oz. |
| Oil lavender flowers | 40 drops |
| Glycerite starch | 4 av. oz. |
| Distilled witch hazel extract, enough to make | 2 fl. oz. |

Dissolve the boric acid in 16 ounces of the witch hazel extract, macerate the quince seed in the solution for three hours, strain, add the glycerin, carbolic acid and glycerite, and mix well. Mix the alcohol, cologne water, lavender oil and mucilages, incorporate with the previous mixture and add enough witch hazel extract to bring to the measure of 32 fluidounces.—Midland Druggist.

**Face Cream.**—

| | | |
|---|---|---|
| White wax | ½ | ounce |
| Spermaceti | ½ | ounce |
| Lanolin | 1 | ounce |
| Oil of sweet almonds | 3 | ounces |

Melt in a porcelain dish, remove from the fire and add

| | |
|---|---|
| Orange flower water | 1 ounce |
| Tincture of benzoin | 3 drops |

Beat briskly until creamy.—Druggists Circular and Chemical Gazette.

**White Sealing Wax.**—

| | |
|---|---|
| Bleached shellac | 28 parts |
| Venice turpentine | 13 parts |
| Plaster of paris | 30 parts |

—Drug Circ.

**White Rose Extract.**—

| | | |
|---|---|---|
| Rose oil | 25 | minims |
| Rose geranium oil | 20 | minims |
| Patchouli oil | 5 | minims |
| Ionone | 3 | minims |
| Jasmine oil (synthetic) | 5 | minims |
| Alcohol | 10 | ounces |

—Druggists Circular and Chemical Gazette.




THE

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